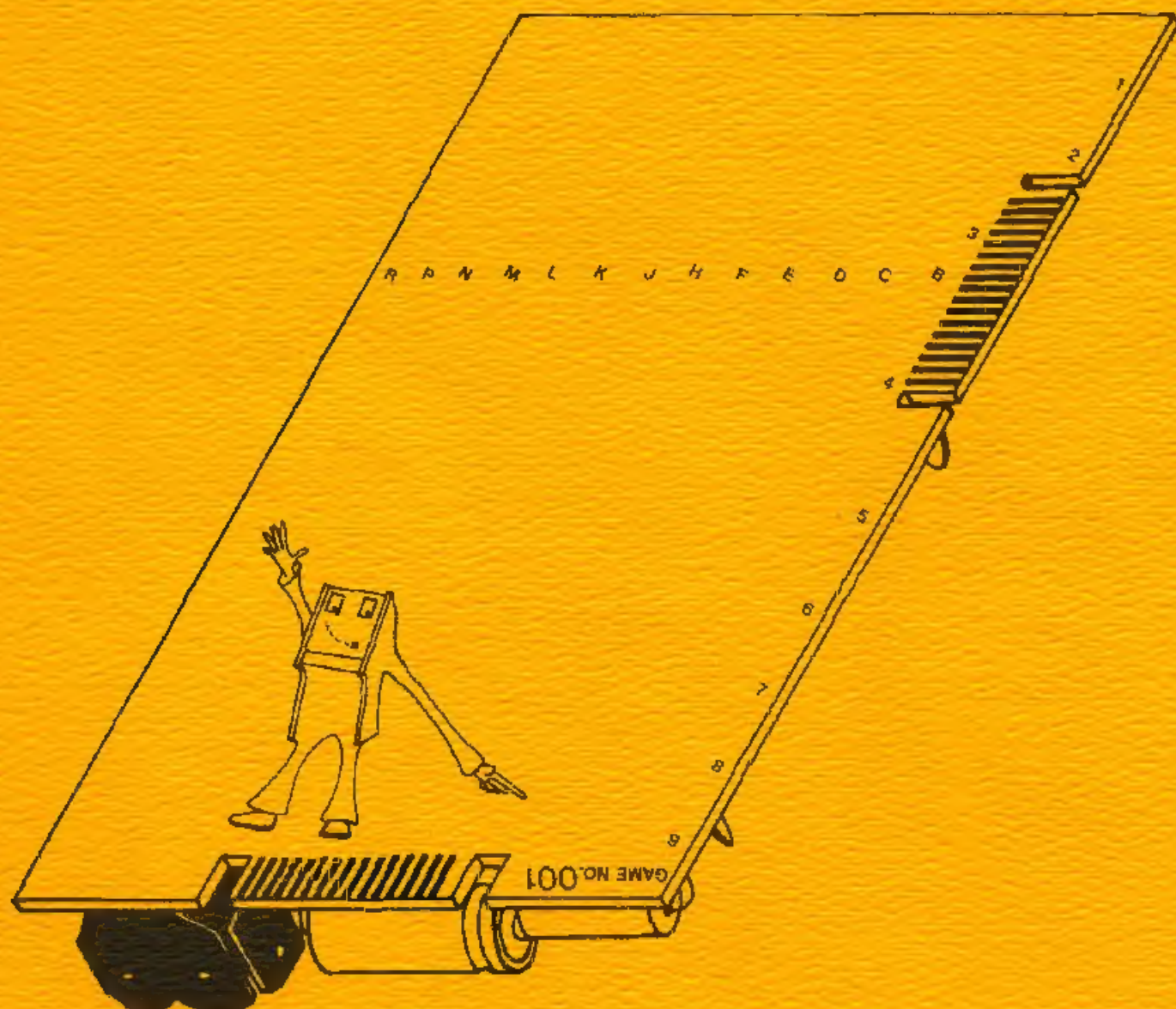


Operation, Maintenance and Service Manual
Complete with Illustrated Parts Catalog


ATARI®

GAME SERIAL NUMBER LOCATION

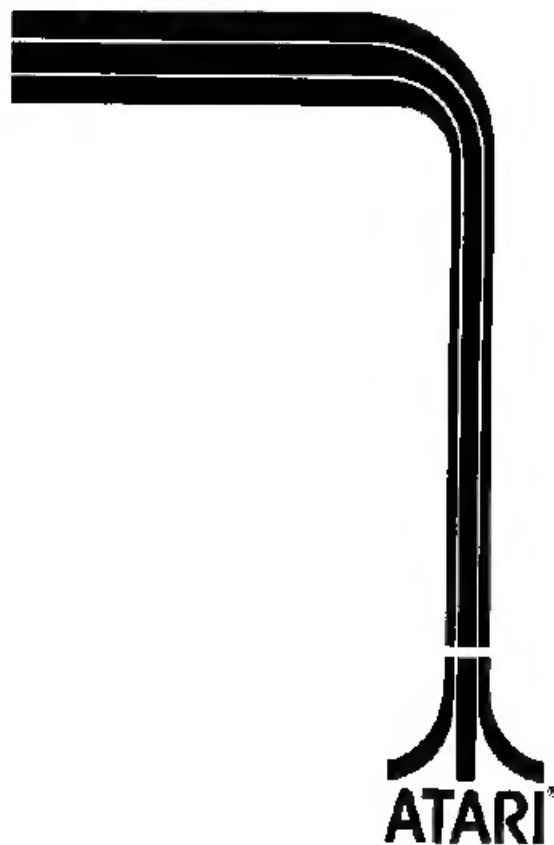
Your game's serial number is stamped on the circuit (back) side, bottom right corner, of the printed circuit board—see the illustration below. The same number is also stamped on the TV monitor chassis and on the label located on the rear of the game cabinet. Please mention this number whenever calling your distributor for service.



FIRE TRUCK™

Operation, Maintenance
and Service Manual

Complete with Illustrated Parts Catalog



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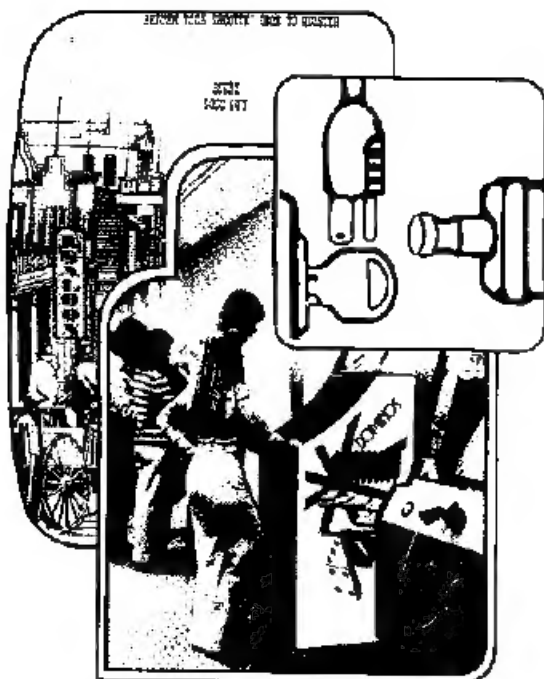
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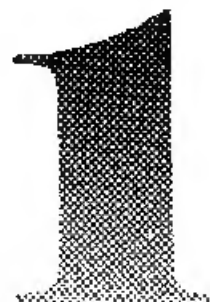


LOCATION SETUP

A. INTRODUCTION

Atari has added a new dimension to the video game world with the first "cooperative" driving game for one or two players—Fire Truck™. A seat assembly and an upright cabinet connected together make up the game. Each assembly contains a player control panel. The front cab and the back trailer of the hook-and-ladder firetruck are steered individually, unless it is a one-player game, in which case the computer controls one half of the truck (either the front or the back).

FIRE TRUCK™



In a two-player game, one person sits and drives the cab via the cabinet steering wheel. The second player stands and drives the trailer via the back steering wheel (which is part of the seat assembly). The object of the game is to accumulate a high score by steering the fire truck through the course without crashing, or crashing as little as possible. For a detailed description of game play see Chapter 2.

A 23-inch TV monitor is mounted in the top of the upright cabinet, with the monitor viewing screen tilted slightly back from a vertical position. Player-operator controls are mounted directly below the TV monitor on the front of the upright cabinet, and on the back top of the seat assembly.

Two identical coin mechanisms are mounted on the lower front center of the seat assembly, below the player controls. Either of these two mechanisms can initiate play. The cash box is located behind a locked access door below the coin mechanisms.

B. GAME INSPECTION

Remove the contents from both shipping cartons. After attaching the front and back cabinet assemblies, attach the harness connectors. Insert and tighten three hex-head bolts with three spacers into the steel bracket. After this preliminary assembly, follow the procedures below to ensure that your game is in perfect condition.

1. Examine all external parts of the game cabinet for dents, chips, or broken parts.
2. After determining that the game has been received in good condition, unlock and open the rear access door. Carefully inspect the interior and verify that:
 - All plug-in connectors are firmly seated.
 - All integrated circuits in sockets on the game printed circuit board are firmly seated.
 - The fuses are all seated in their holders.
 - No harness wires are disconnected.
 - No loose foreign objects are present, especially metal objects that could cause electrical problems.

Be sure all major assemblies are checked. Check the game printed circuit board (PCB), the transformer, the two coin mechanisms, the speakers, the fluorescent

light, and the player controls. Also, be sure the TV monitor is secure in its mounting.

C. LOCATION OF SERIAL NUMBER

The serial number for Fire Truck is located on a metallic label in the upper left-hand corner on the back of the game cabinet. This serial number also appears in the corner (common to both edge connectors) on the back of the PCB, inside the game cabinet. See the illustration on the inside front cover of this manual.

D. INSTALLATION REQUIREMENTS

Power Requirements and Line Voltage Selection

Fire Truck is shipped for operation at 110 VAC, 60 Hz. Power consumption is approximately 150 watts. However, if your local voltage is not 110 volts, follow this procedure. You must select one of four connectors at the power supply and plug it into the voltage selection socket. Figure 11 shows the four connectors with one of them plugged in. The plugs are identified by wire color as listed in this figure. Note that there are two basic operating voltages — 110 VAC, 60 Hz, and 220 VAC, 60 Hz, with provisions for low line voltage in each case. To insure proper operation, measure line voltage. If voltage is consistently below 100 V (for 110 VAC lines) or consistently below 210 V (for 220 VAC lines), use the low voltage connections. Use the black plug for low 110 VAC lines and the green plug for low 220 VAC lines.

Temperature Range

Location and storage should not be below 0 degrees Celsius (32 degrees Fahrenheit), and no higher than 49 degrees Celsius (120 degrees Fahrenheit).

Humidity Range

Relative humidity for location or storage should be no more than 95%.

Location Space Requirements

The game requires a minimum of

- 160 centimeters (63 inches) of vertical clearance
- 64 centimeters (25 1/4 inches) of width space
- 160 centimeters (63 inches) of depth space

See Figure 11 for details.

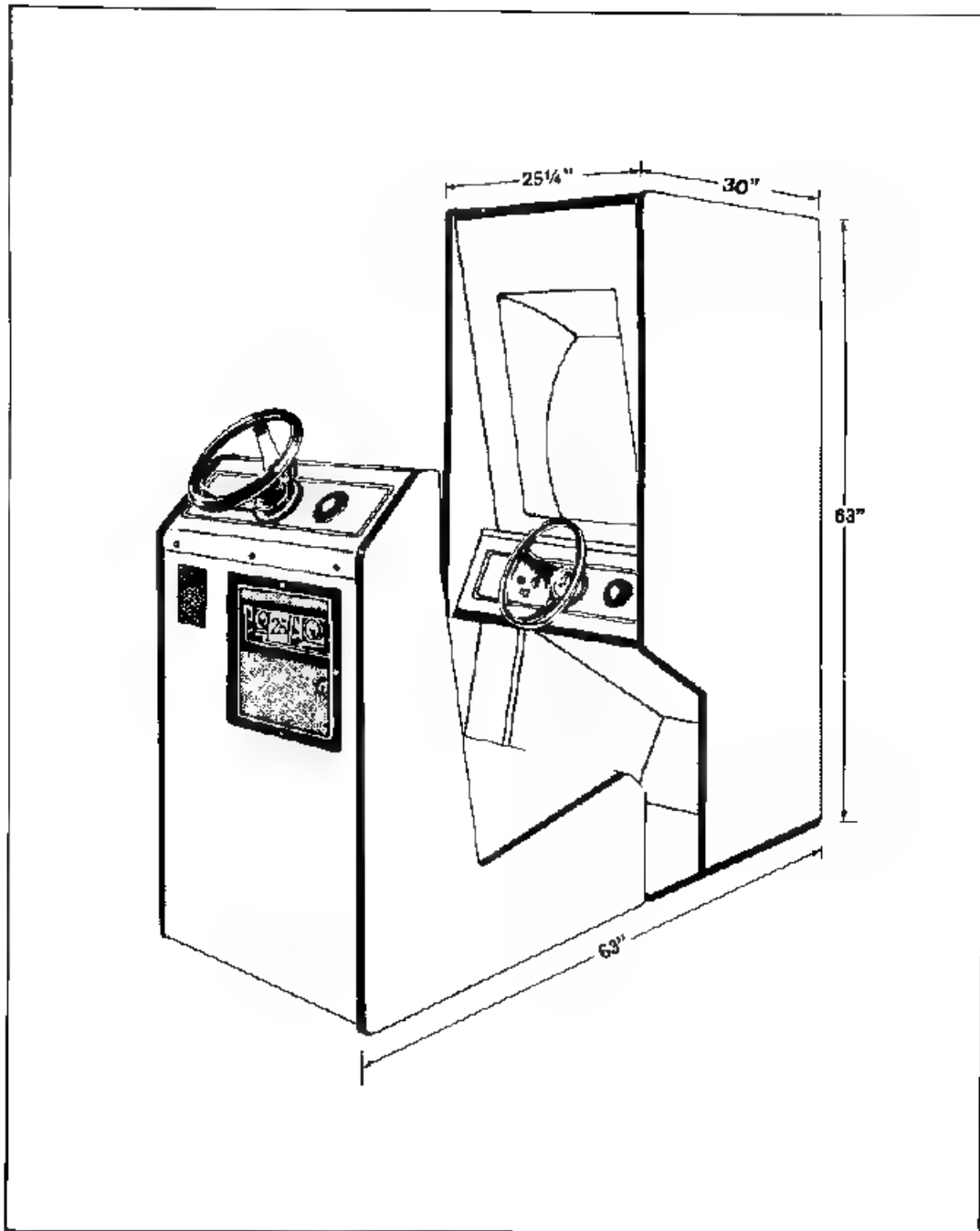


Figure 1-1 Location Space Requirements

Type of Power Cord

Atari has added a strain relief power cord to Fire Truck. The advantage of this type of power cord is that if pulled accidentally, the strain relief will hold the cord in place at the pedestal base. The "elastic strain relief cushions" the impact of the shock and prevents the cord from pulling the wires out of the harness connector. Check the power cord assembly periodically for damage.

E. INTERLOCK AND POWER ON/OFF SWITCHES

To minimize the hazard of electrical shock while you are working inside the game cabinet, two interlock switches have been installed at the rear door assembly and at the coin door. These switches remove all power from the game while the doors are open. To help you

conserve energy, a power on/off switch has been installed on the game so that it can be turned off during closed periods. This switch is located at the rear of the upright cabinet toward the top, as shown in Figure 1-3.

Check for proper operation of the interlock switches by performing the following steps:

1. Unlock and open the rear door assembly and the coin door.
2. Plug the AC power cord into a 110-volt source. If voltage is consistently less than 110 vAC, make sure that you use the black plug instead.
3. Set the power on/off switch to the on position.
4. Close both doors. Within approximately 30 seconds, the TV monitor should display a picture.

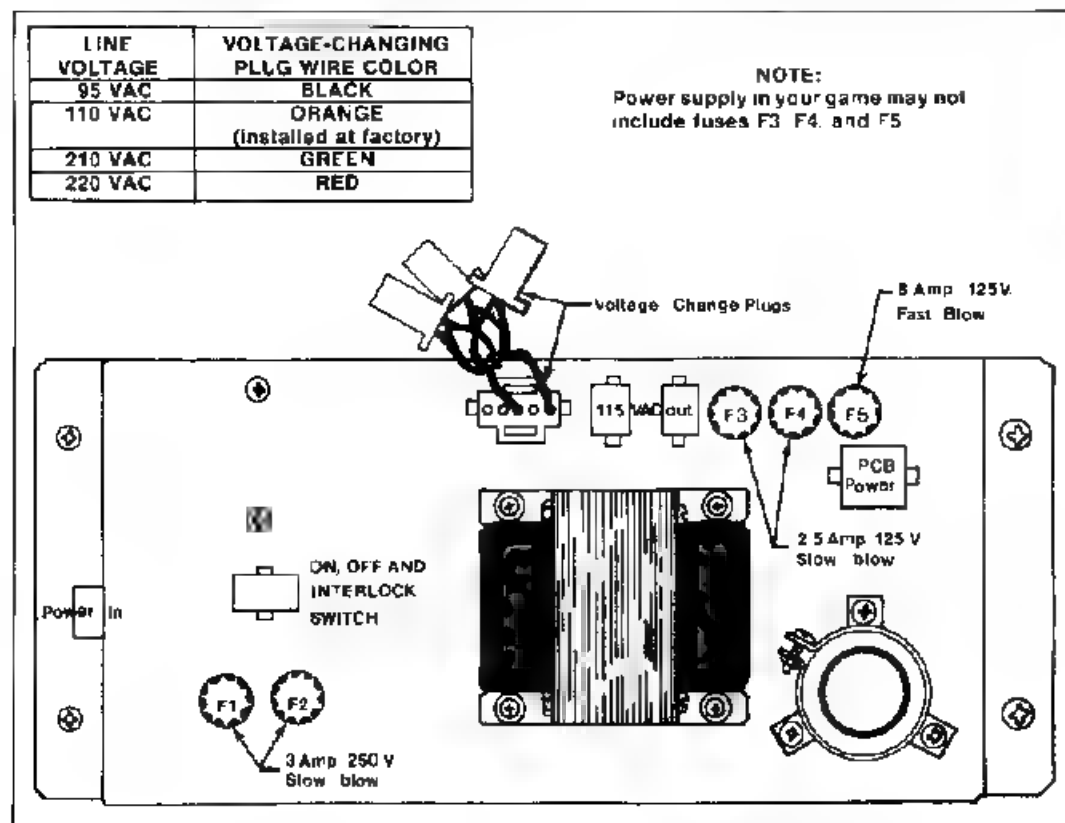


Figure 1-2 Location of Voltage-Changing Plugs on the Power Supply

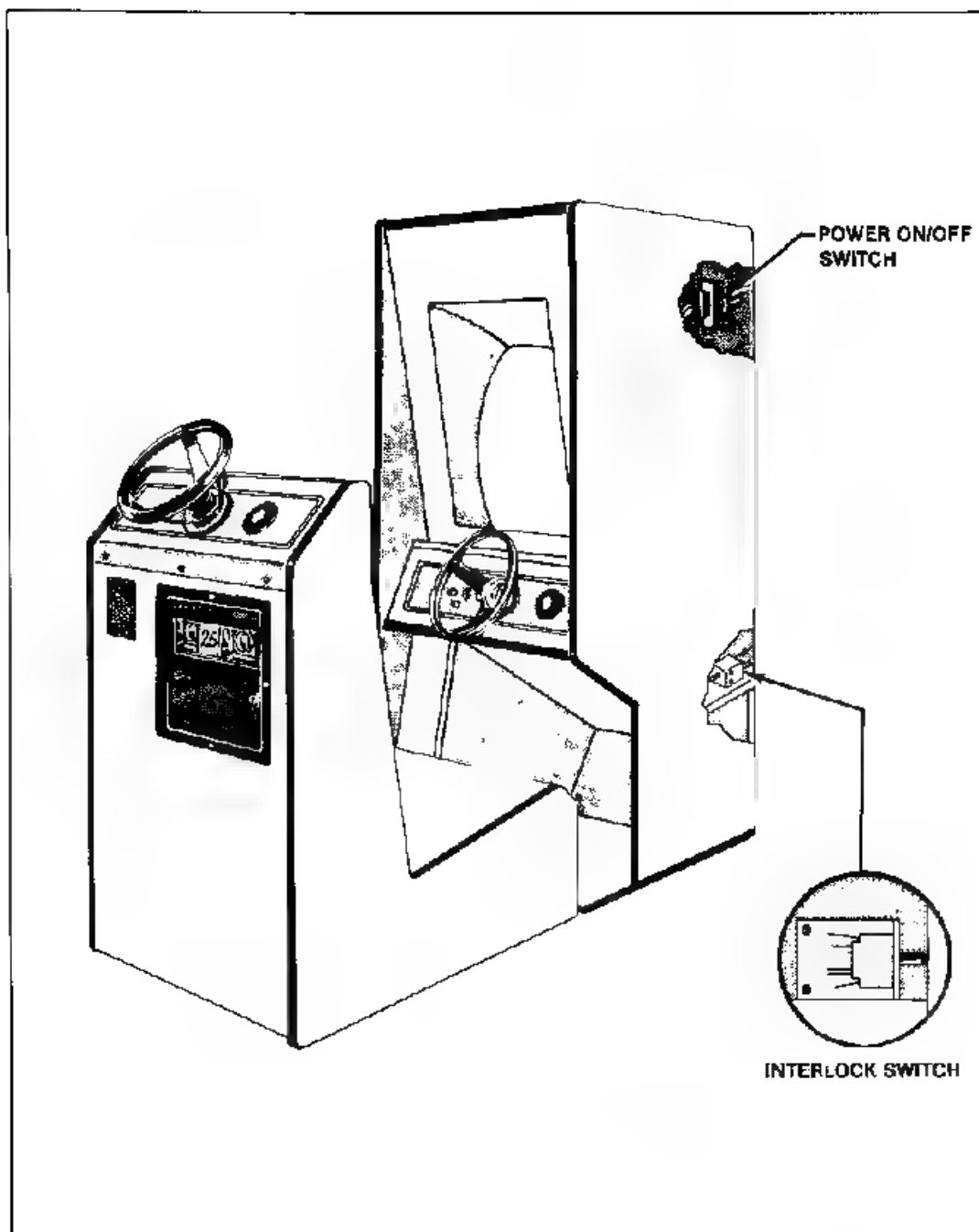


Figure 13 Location of Interlock and Power On/Off Switches

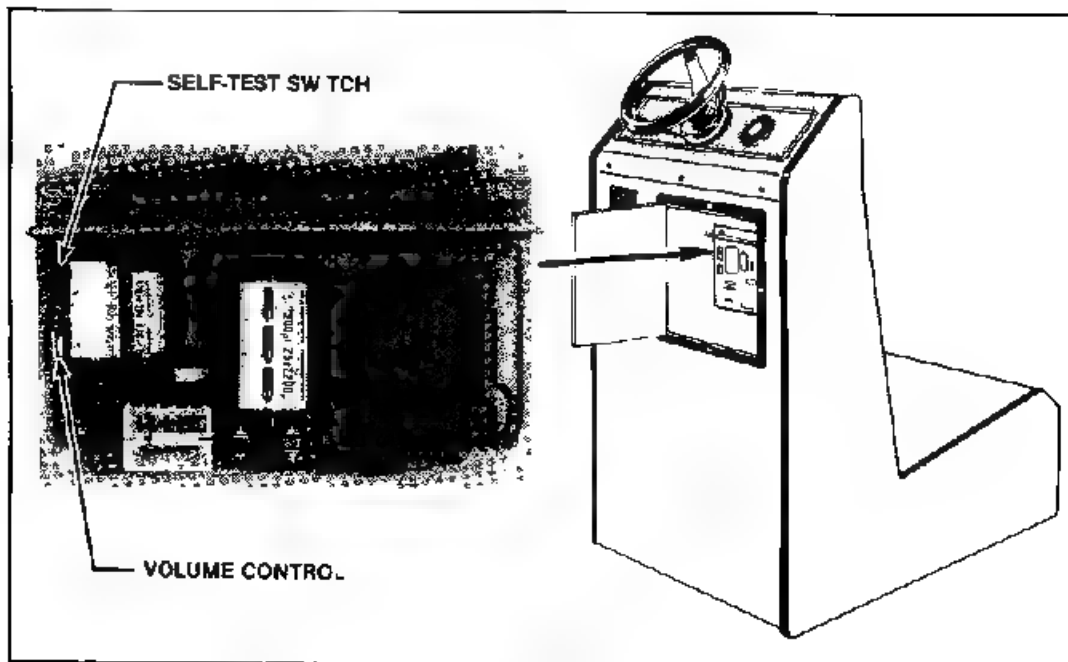


Figure 1-4 Location of Volume Control and Self Test Switch

- 5 Slowly open each door until the TV monitor picture disappears. The picture should disappear when the rear door is opened less than one inch from the top.
- 6 If the results of Step 5 are satisfactory, the interlock switches are operating properly. If the picture does not disappear as described, check to see if the appropriate switch is broken from its mounting or stuck in the on position.
- 7 Close and lock both doors.

F. VOLUME CONTROL

If volume is incorrect for your location, open the coin door and adjust the volume control. See Figure 1-4 for location of the volume control.

G. SELF-TEST PROCEDURE

Fire Truck will test itself and provide data to demonstrate that the game's circuitry and controls are working properly. This procedure uses the TV monitor and the speakers; no additional equipment is required. SEE FIGURE 1-4 FOR LOCATION OF THE SELF-TEST SWITCH. To start the procedure over from the beginning, turn the switch off, then on again. This will return the test to Step 1 and can be done at any time during the procedure. See Table 1-1 for further details and instructions.

on the self-test. We suggest that you run the self-test procedure each time the coin box is emptied.

H. OPERATOR OPTIONS

Options for the Fire Truck game offer maximum player appeal for each game location. These options are listed in Table 1-2. They are preset for a certain game setup during production. To determine how the switches have been set for your game, compare the TV monitor viewing screen during the attract mode with the information in Table 1-2.

To change the toggle positions of the switch assembly and set the desired options, the printed circuit board (PCB) must be removed according to the following procedure:

NOTE

Fire Truck is the first Atari game to include a new style of easy-access PCB. The radio frequency shield has been redesigned to use only three quarter-turn fasteners, as a direct result of the design input.

- 1 Unplug the game, unhook and open the rear door assembly.

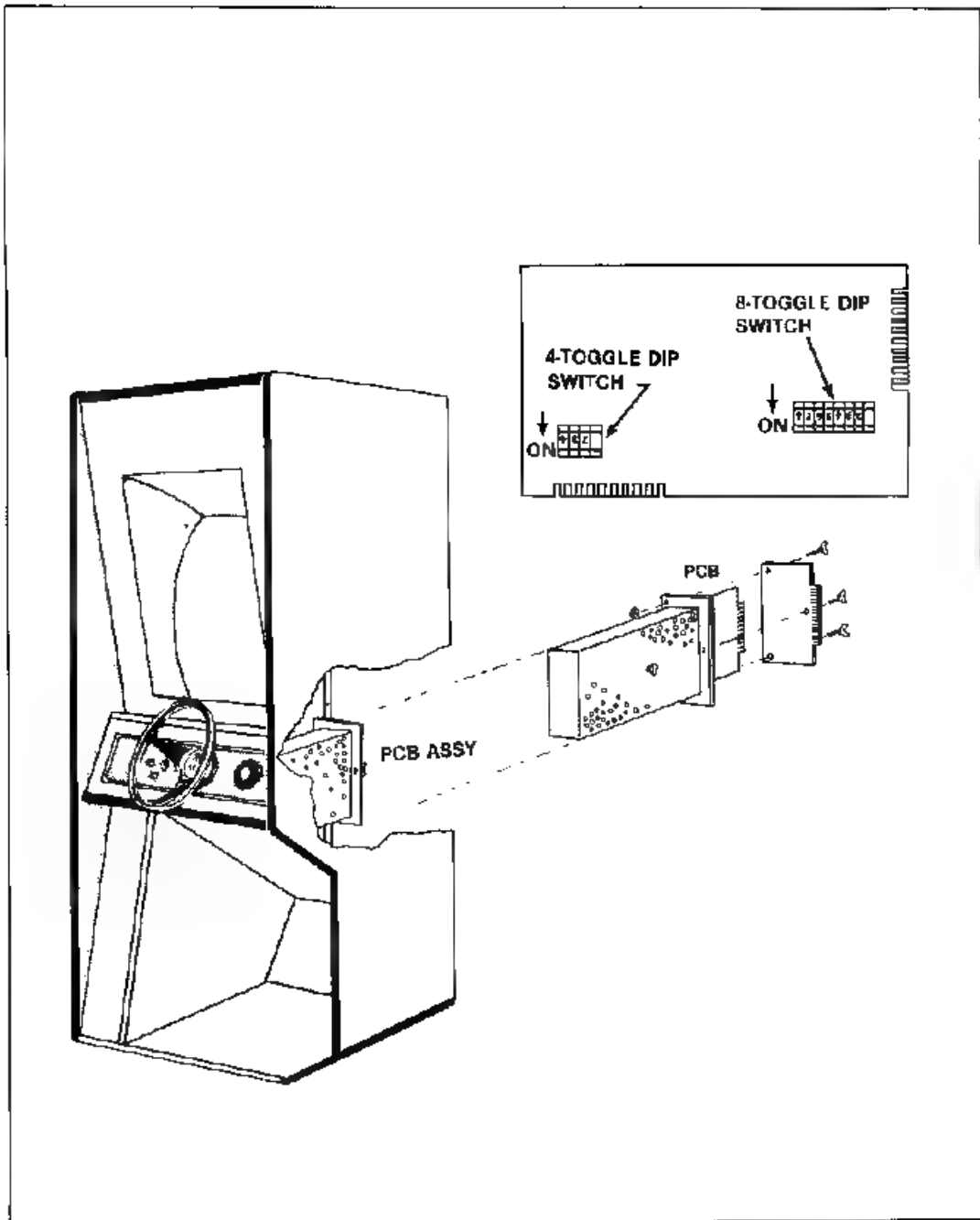






Figure 1-5 Option DIP Switches on Game PCB

Table 1-1 Self Test

TEST	INSTRUCTION	RESULTS IF TEST PASSES	RESULTS IF TEST FAILS
1	<p>Unlock and open the coin door. Locate the self test switch and turn to the on position.</p> <p>The ROM and RAM test will follow.</p>	<p>There are four ROM's programmed into Fire Truck. If they all check satisfactory, there is no visible change or indication on the TV screen.</p> <p>Throughout the self test, a set of stationary graphics appear in a rainbow pattern (dark to light) from the left side to the right side of the screen.</p>	<p>1, 2, 3 and/or 4 is displayed in the lower left corner of the TV screen. These numbers correspond to the failing ROM or ROM's.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>ROM 1 ERROR</p> </div> <div style="text-align: center;">  <p>ROM 4 ERROR</p> </div> </div> <p>These examples represent two of the possible four ROM's which could be in error.</p> <p>If the zero-page RAM is bad, a 0 is displayed in the lower left corner of the screen. A 5 is displayed if the screen RAM is bad.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Bad screen RAM</p> </div> <div style="text-align: center;">  <p>Bad Zero-page RAM</p> </div> </div>

<p>2 The next phase of the self test checks the LED switches and both steering wheels on each control panel</p> <p>individually press the six LED switches</p>	<p>An electronic pop sound occurs each time a switch is pressed and again when the switch is released</p> <p>The same pop sound occurs each time there is a change in the direction in which the wheel is being turned</p> <p>The pop sound occurs whenever a coin switch wire is tripped</p> <p>No sound indicates a stuck or broken switch, or an open or shorted harness</p>
<p>3 Trip the right and left coin switch wires</p>	<p>Turn each steering wheel to the right then back to the left. Then reverse the procedure</p>

2. Locate the radio frequency (RF) shield assembly immediately inside the cabinet on the right. See Figure 1-5. On one end of the box is a printed circuit board (PCB) with an edge connector coming from the edge of the board. (The RF shield assembly is an aluminum box with small holes.)
3. Turn the three quarter-turn fasteners on the RF Shield assembly by turning the wing nuts ¼ turn.
4. Carefully pull out the PCB and the RF shield board as one unit. These would not normally need to be separated when making option switch changes.
5. Set the switches for the desired options, as shown in Table 1-2.
6. Reinstall the PCB following steps 1 through 4 in reverse order. Do not force or bend the printed circuit board. Before reinstalling, always inspect the PCB for damage. Close and lock the rear access door.
7. Plug in the game and verify options functions by playing it.

Table 1-2 Operator Options

OPTION	8-TOGGLE DIP SWITCH ON GAME PCB — TOGGLE NO.							
	1	2	3	4	5	6	7	8
EXTENDED PLAY*								
No Extended Play			ON	ON				
Liberal (Easy to Earn)			ON	OFF				
Medium			OFF	ON				
Conservative (Hard to Earn)			OFF	OFF				
GAME TIME								
60 Seconds		N			ON	ON		
90 Seconds		O			ON	OFF		
120 Seconds		T			OFF	ON		
150 Seconds					OFF	OFF		
GAME LANGUAGE								
English							ON	ON
French							ON	OFF
Spanish							OFF	ON
German							OFF	OFF
OPTION	4-TOGGLE DIP SWITCH ON GAME PCB — TOGGLE NO.							
	1	2	3	4				
GAME COST								
Free Play		N			ON	ON		
Two Plays Per Coin		O			ON	OFF		
One Coin Per Play		T			OFF	ON		
Two Coins Per Play					OFF	OFF		

*See Table 1-3 for point scores required to earn extended play.

Table 1-3 Points Required to Earn Extended Play

Extended Play Option Setting	Game Length Setting			
	60 seconds	90 seconds	120 seconds	150 seconds
	Extended play granted for scoring			
	90 pts	140 pts	190 pts	240 pts
Liberal	100	160	220	270
Medium	120	180	240	300
Conservative				



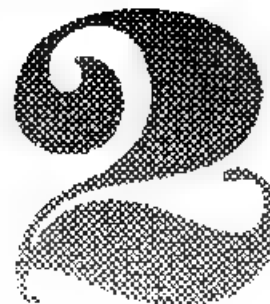
GAME PLAY

Fire Truck has three modes of operation:

- Attract — power applied or at the end of a game
- Ready-to-Play — coins accepted
- Play — after one of the Start buttons is activated

A. ATTRACT MODE (See Figure 2.1)

The attract mode begins when power is applied to the game and the power switch is turned on. The power on/off switch is located at the back of the cabinet, as shown in Figure 1.2. This mode also occurs at the end of every game. When the proper amount of coins clear the coin acceptor, the attract mode ends.



FIRE TRUCK™



Figure 2-1 Attract Mode

During the attract mode the Fire Truck is shown in the middle of the screen with the roadway scene and hazards passing by. *BONUS* information and *TOP SCORE* information appear (alternately) at the top of the viewing screen. The previous game *SCORE* and driver rating message *SORRY SO-SO GOOD* or *ACE!* appear alternately at the bottom of the screen. The player controls and game sounds are inactive during this mode.

B. READY-TO-PLAY MODE (See Figure 2-2)

When the correct amount of coins clear the coin acceptor, the ready-to-play mode is initiated. There is no change on the TV monitor from the attract mode. The Start buttons on the control panel flash on and off according to the amount of credit registered for the game. If there is sufficient credit for a one-player game

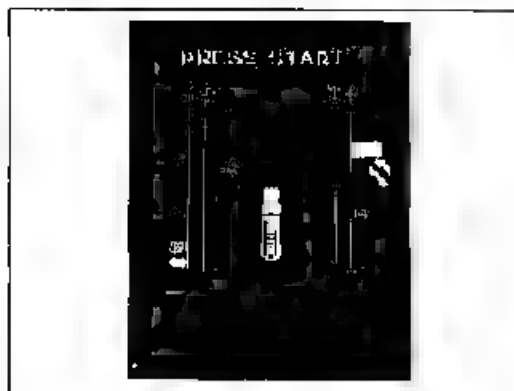


Figure 2-2 Ready-to-Play Mode

only the Front and Back Player Start buttons flash. If there is sufficient credit for a two-player game (or more), all of the Start buttons flash.

It is during the ready-to-play mode that players have the opportunity to select the "Hard" or "Easy" track. If the track select button is lit, the hard track will be displayed for the duration of one game. The button has to be reactivated (lit) at the beginning of each game for the hard track to be displayed.

This mode also occurs at the end of game play if there are credits remaining.

C. PLAY MODE (See Figure 2-3)

The play mode begins when one of the Start buttons is pressed. If the Front Start button or the Back Player Start button is pressed, the words *PRESS START* appear on the top and the bottom of the TV screen for approximately five seconds. This allows time for a second player to enter the game, even though additional credits needed to do so. All other words disappear from the screen. If either one of the Two Player Start buttons is pressed, game play begins immediately.



Figure 2-3 Play Mode

See Section H in Chapter 1 for various operator options: game time, cost, extended play levels, etc.

As a one-player game, players steer either the cab or the trailer; the computer controls the other half of the Fire Truck. As a two-player game, the seated player steers the cab, the standing player controls the trailer.

The object of the game is to crash as often as possible, thereby obtaining a high point score. The front

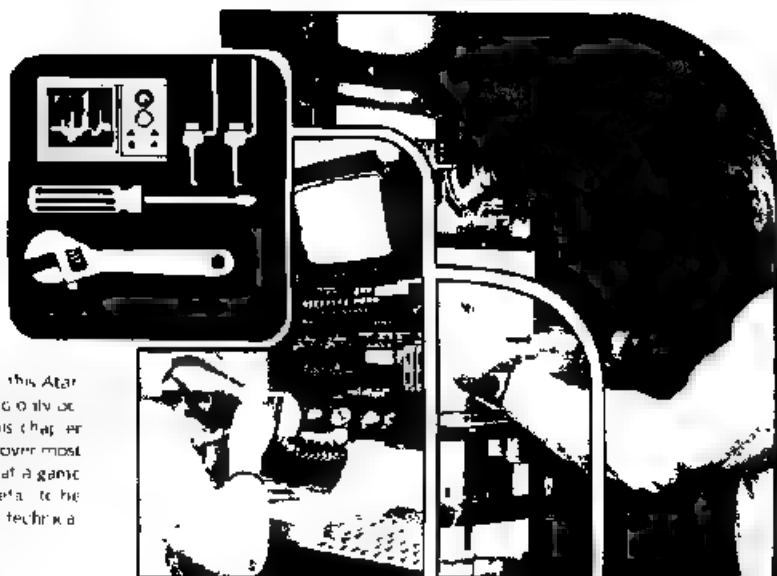
player (in a one- or two-player game) operates the accelerator foot pedal. In a one-player game, when the back player controls are used, the acceleration is controlled by the computer.

Whenever any part of the Fire Truck comes in contact with the side of the road (sidewalk) or another obstacle, the TV monitor flashes, all motion freezes, a crash sound is heard over the speakers, and the word CRUNCH is displayed on the screen. Acceleration then gradually resumes if controlled by the computer.

Points are awarded in increments of one. Each time ten points are earned (by passing certain invisible points on the track), the sound of three ringing bells is heard over the game speakers. Other game sounds include the

- Engine sound
- Siren sound
- Screech noise
- Bell and Horn sound (both activated by buttons on the control panels)
- Extended Play tone
- Crash sound

When extended play is earned, the track goes into a white video display for the remainder of such bonus time. It is possible to influence the direction of one part of the Fire Truck by radically steering the other. For example, if the trailer is steered extremely to one side or the other, the cab steering will be hampered and a "static" noise will be heard over the game speakers.



Due to its solid state electronic circuitry, this Atari unit should require very little maintenance and only occasional adjustment. Information given in this chapter and elsewhere in this manual is intended to cover most servicing situations that may be encountered at a game site. The procedures given are in sufficient detail to be understood by a person with moderate technical background.

NOTE

If reading through this manual does not lead to solving a specific maintenance problem, you can get help from the following two Atari Customer Service Offices:

Atari New Jersey Customer Service Office
46 Colonial Drive • P.O. Box 454
Totowa, NJ 08054
Tel: 374-5477
Monday-Friday 8:30-5 pm Eastern time

Dial toll-free from anywhere in the shaded area on map below: 800-451-5374

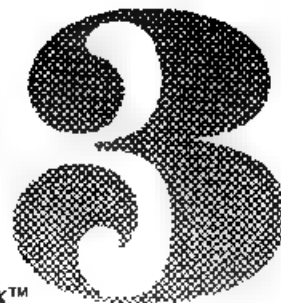


From New Jersey and elsewhere in the U.S.: 201-461-0491

Atari California Customer Service Office
1344 Bordeaux Drive • Sunnyvale, CA 94086
Tel: 951-1103
Monday-Friday 7:30-4:30 pm Pacific time

From California, Alaska and Hawaii: (408) 745-2900
From the remaining 47 states: dial toll-free: 800-538-1511

MAINTENANCE AND ADJUSTMENTS



FIRE TRUCK™

A. CLEANING

The exteriors of game cabinets and Plexiglas® panels may be cleaned with any non-abrasive household cleaner. If desired, special coin machine cleaners that leave no residue can be obtained from your distributor. Do not dry-wipe the acrylic plastic panels, because any dust can scratch the surface and result in fogging the plastic.

B. COIN MECHANISM

Components On Coin Door

Figure 3-1 shows the back side of the coin door assembly where the game's two coin mechanisms are mounted. Included is the lock-out coil assembly. The lock-out wires are connected to this assembly but are hidden behind the coin mechanisms. Lowering the game causes the lock-out wires to retract far enough to allow genuine coins to reach the coin box. When AC power to the game has already been turned off, the lock-out coil is de-energized, causing the lock-out wires to move out far enough to divert coins to the return chute.

Directly below each coin mechanism is a secondary coin chute and a coin switch with a trip wire extend-

ing out to the front edge of the chute. When the trip wire is positioned correctly, a coin passing down the secondary chute and into the coin box will momentarily push the trip wire down and cause the switch contacts to close.

Also shown in the photograph is a slam switch assembly. It has been included to discourage any players who might try to obtain free game plays by violently pounding on the coin door to momentarily close the contacts on a coin switch. The slam switch contacts connect to the microcomputer system, which will ignore coin switch signals whenever the slam switch contacts are closed.

Access to Coin Mechanisms

To remove jammed coins and for maintenance cleaning, each magnet gate assembly can be hinged open without removing it from the door as shown in Figure 3-2. Or, if necessary, each coin mechanism can be entirely removed from the door merely by pushing down on a release lever and simultaneously tilting the mechanism back, then lifting it up and out. This is shown in Figure 4-3.

Plexiglas® is a registered trademark of Rohm & Haas Company.

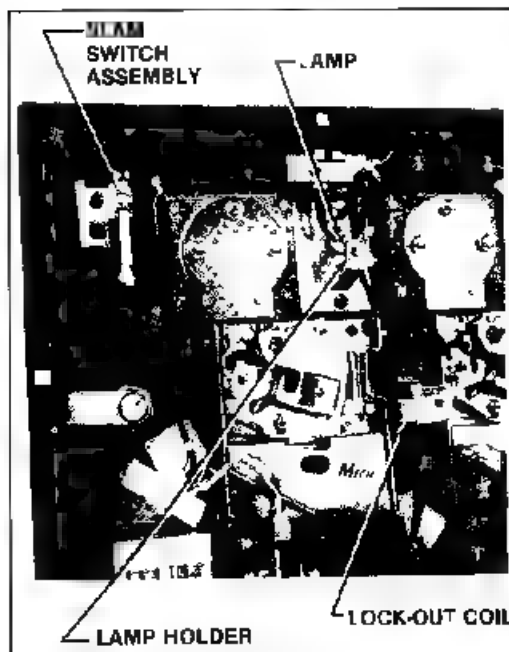


Figure 3-1 Coin Door Assembly



Figure 3-2 Hinging Open the Magnet Gate Assembly



Figure 3-3 Removal of Coin Mechanism

Cleaning of Coin Paths

CAUTION

The use of an abrasive (such as steel wool or a wire brush) or a lubrication on a coin mechanism will result in a rapid buildup of residue.

By talking to many operators, we have found that the best method of cleaning a coin mechanism is by using hot or boiling water and a mild detergent. A toothbrush may be used for those stubborn buildups of residue. After cleaning, flush thoroughly with hot or boiling water, then blow out all water with compressed air.

Figure 3-4 shows the surfaces to clean inside the coin mechanism. These include the inside surface of the

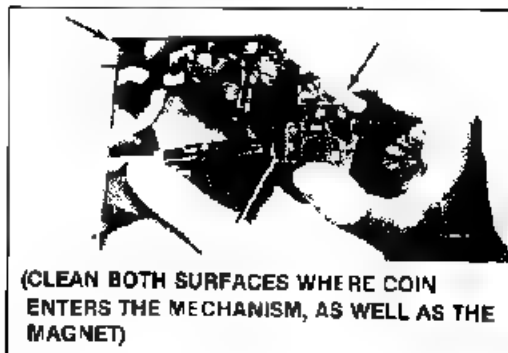


Figure 3-4 Surfaces to Clean Inside the Coin Mechanism

manipulate and the corresponding surface of the gate assembly. There may also be metal particles clinging to the magnet itself. To remove these you can guide the point of a screwdriver or similar tool along the edge of the magnet.

If coins are not traveling as far as the coin mechanisms, you will need to clean the channel beneath the coin slot. To gain access to this channel, use a 3/8-inch wrench and remove all three nuts that secure the cover plate (refer to Figure 3-5). Removing the plate will provide access to the entire channel.

Also clean the inside surfaces of the secondary coin chutes, but when doing this be careful not to damage or bend the trip wires on the coin switches.

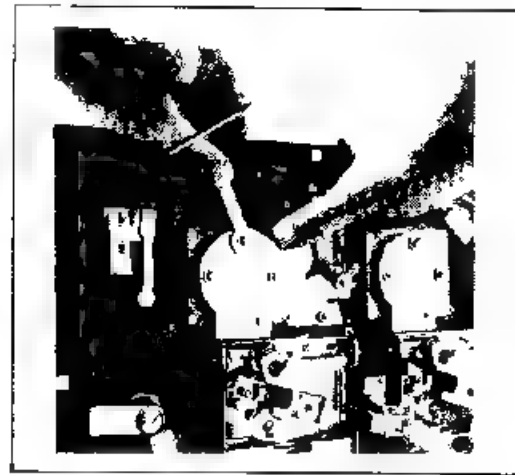


Figure 3-5 Removal of Plate Covering Rear of Coin Slot

Lubrication

Do not apply lubrication to the coin mechanisms. The only points that may need lubrication (and only rarely) are the shafts of the scavenger buttons, coin rejection buttons, where they pass through the coin door. Apply only one drop of light machine oil, and be positive that no oil drops down onto a coin mechanism. Figure 3-6 shows this lubrication point.

Adjustment of Coin Switch Trip Wire

In order for a coin switch to operate reliably when a coin travels down the secondary coin chute, the rest position of its trip wire should be as shown in Figure 3-7. Use extreme care when handling or touching these wires.

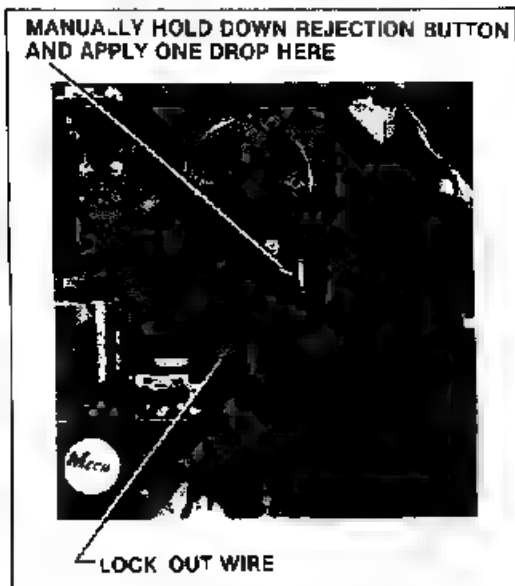


Figure 3-6 Close-Up View of Lubrication Point

In Figure 3-7 you will note that the coin switch trip wire is oriented into the V of the secondary coin chute. The wire should extend to only about 1/8" beyond the chute.

A retaining clip holds the wire onto the switch actuating stud. If you should lose a retaining clip, it is not lost. Just crimp the switch actuating stud over the trip wire with a pair of pliers.

Mechanical Adjustments on Coin Mechanism

Coin mechanisms are adjusted prior to shipment from the factory and normally will retain these adjustments for many months. If, due to wear or other causes, it becomes necessary to make new adjustments, remove the coin mechanism from the coin door. Then take it to a clean well-lighted area where it can be placed in a vertical position on a level surface, such as a bench top. Besides a screwdriver, you will need a set of several coins, including both new and old worn ones. Figure 3-8 shows an exploded view of the mechanism and gives procedures for adjusting the kicker separator and the magnet gate. These adjustments should only be done by someone who has experienced in servicing coin mechanisms and who understands their operation.

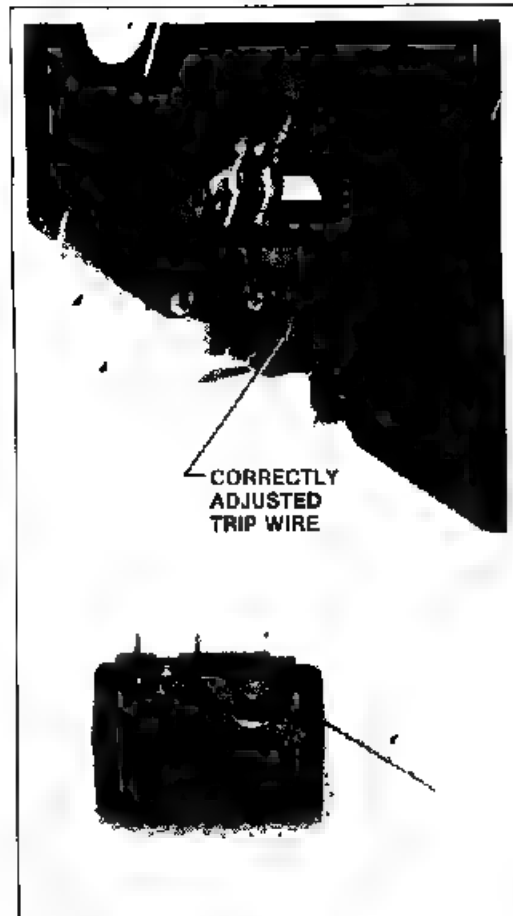


Figure 3-7 Detail View of Coin Switch and Trip Wire

General Troubleshooting Hints

The first action is to look for jammed coins. After these have been removed, examine the coin path for presence of foreign material or loose objects, such as chewing gum, small metallic objects, paper wads, etc. In cases where game usage is heavy, it may be necessary to clean the entire coin path periodically in order to prevent build-up of contaminants that can hinder the movement of coins through the mechanisms. Also confirm that the trip wire on each coin switch is intact and is properly adjusted. If troubles still persist, check the conditions and positions of the lock-out wires, and the mechanical adjustments on the coin mechanisms, before suspecting the electronics. If a coin mechanism

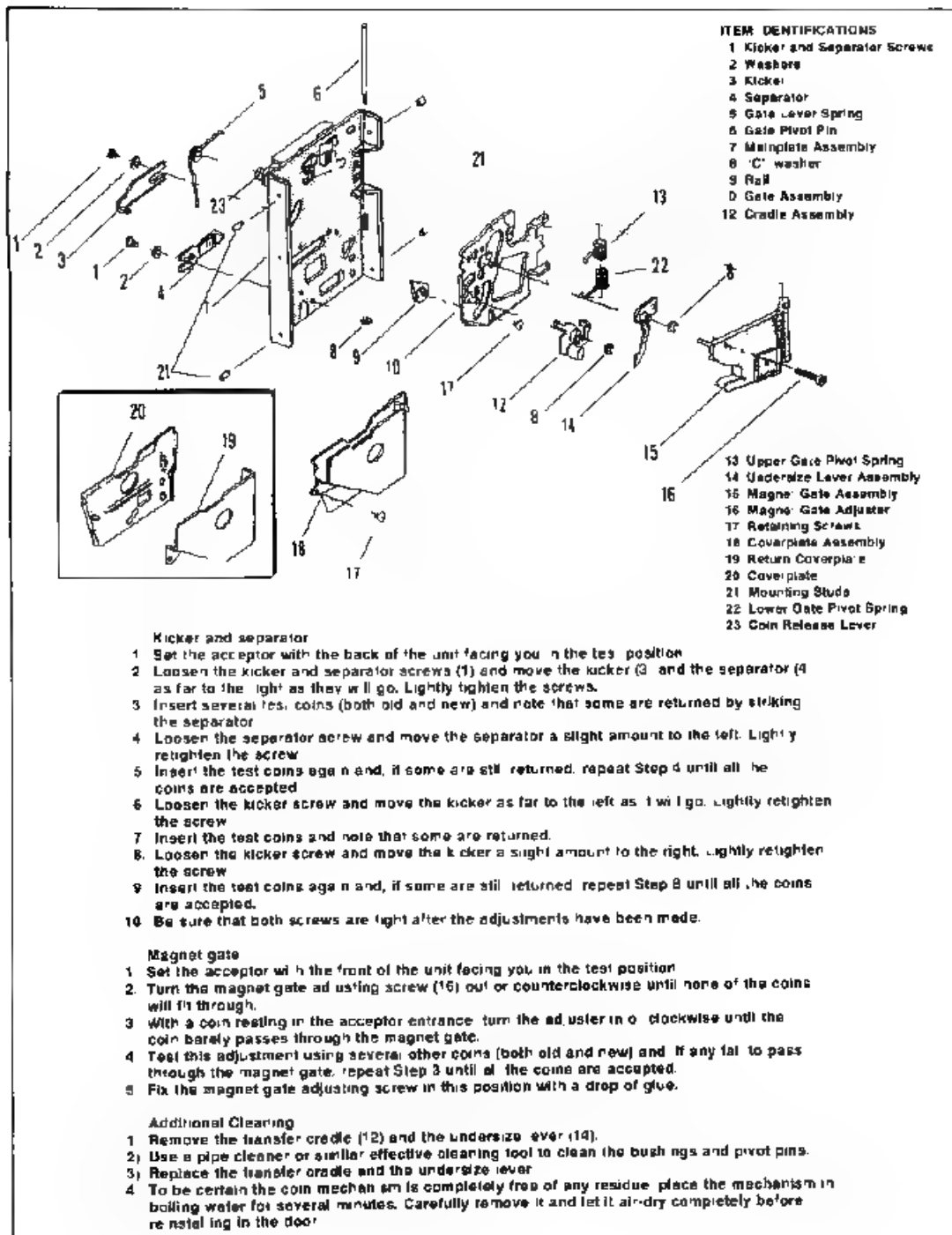


Figure 3-8 Adjustments on Coin Mechanism

rejects genuine coins, try to readjust it. If this is not successful, then replace it with a working mechanism.

Correct operation of the slam switch can be verified by putting the game into the test mode and performing the switch test, described in Table 1). Correct operation of the other switches and of the lock-out coin can also be checked by the switch test, or else merely by manually operating them and watching game responses as it changes from the attract mode to play mode, and then back to attract mode again.

C. FUSE REPLACEMENT

Fire Truck contains seven fuses, five on the power supply assembly in the lower part of the cab net and two on the TV monitor assembly. All fuses are easily accessible through the rear access door. Replace fuses only with the same type of fuse as follows:

TEC TM-600/623 Monitors

1AC 2-amp and 0.5-amp quick-blow, 250 volts

Motorola M5000/M7000 Monitors

3AC 0.8-amp quick-blow, 250 volts

Power Supply

Fuses F1 and F2 - 3AC 2-amp slow-blow
250 volts

Fuses F3 and F4 - 3AC 2.5-amp slow-blow
125 volts

Fuse F5 - 3AC 8-amp fast-blow, 125 volts

D. TV MONITOR ADJUSTMENTS

CAUTION

For best results be sure the game has been turned on for a while before making any TV monitor adjustments.

NOTE

The TV monitor adjustments are accessible through the rear door panel of the game cab net. These adjustments have to be done while the game is energized. Therefore, only persons familiar with safety measures and repair procedures on electrical equipment should perform them.

The TV monitor should be adjusted only when the picture is distorted or the contrast or brightness seem out of adjustment.

The monitor's adjustments function like those of a conventional home television set, except that the volume adjustment has no effect. Instead, the game produces its sound in circuits separate from the TV monitor. Figure 3-9 shows the location of the adjustments on both TV monitors used by Atari. Your game contains a TV monitor manufactured to Atari specifications by either Motorola or TEC.

When making adjustments, follow these general guidelines:

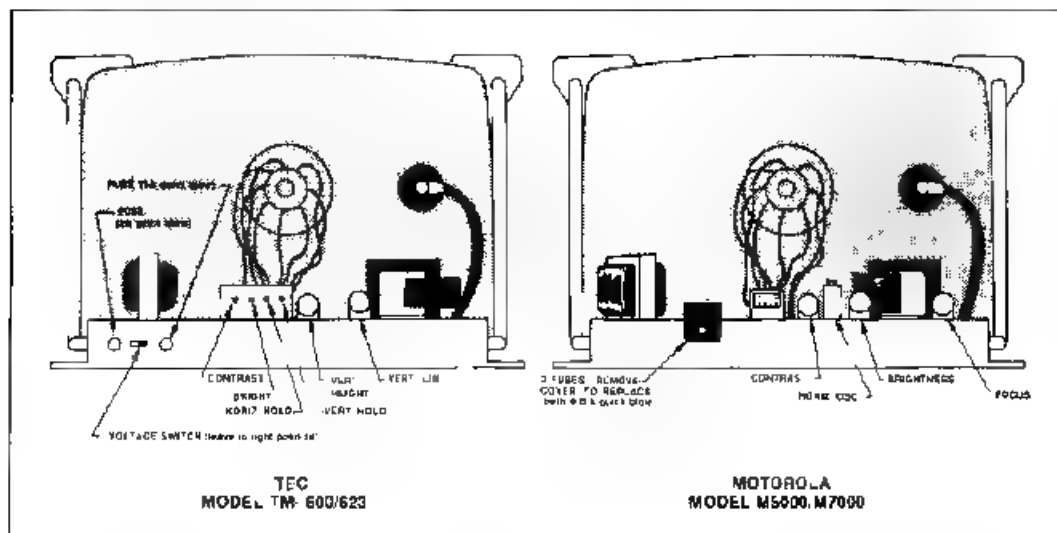


Figure 3-9 Locations of Adjustments on TV Chassis

BRT (Brightness) Perform this adjustment before the contrast. Adjust so that the white lines covering the screen just barely disappear when the brightness is turned up.

CONT (Contrast) Adjust so that the images are as bright as possible against the dark background without being blurred.

HORIZ HOLD (Horizontal Hold) or HORIZ OSC (Horizontal Oscillation) Adjust if the picture is slightly off-center horizontally, if the images appear warped, or if the picture is broken up into a series of diagonal lines. Adjust for a stable, centered picture.

VERT HOLD (Vertical Hold) This needs adjustment only if the picture appears to be rolling up or down the screen. Adjust for a stable, centered picture.

E. TV MONITOR REMOVAL (See Figure 3-10)

Remove three screws (button-head socket cap #10-32) at the top edge of the cabinet and remove the Plexiglas® retainer. Slide the Plexiglas screen (with graphics) out of the cabinet and remove the cardboard bezel. At the back of the cabinet remove the rear door assembly (four wood screws, #8 x 1 1/2").

With the back of the game cabinet exposed, remove four carriage bolts 1/4" 20 x 200 Lg. which secure the monitor to the TV shelf assembly. Disconnect the TV monitor harness and slide the monitor out through the front of the cabinet.

F. LAMP REPLACEMENT (See Figure 3-10)

Fire Truck contains an 18-inch fluorescent lamp inside the top of the game cabinet assembly. To replace the lamp, remove the Plexiglas® retainer and screen as described in Section E (TV Monitor Removal). The fluorescent tube can now be pulled straight out of the cabinet and replaced.

G. SWITCH (LED) AND BUTTON REPLACEMENT (See Figure 3-11)

The Player Start buttons and track select buttons on both control panels are LED (light-emitting diode) switches. The Horn and Bell buttons are actual push button assemblies.

Unplug the power cord before working inside the game cabinet.

To remove the switches and Horn button on the front control panel, it is necessary first to remove the rear door assembly. Reach in through the back of the cabinet and remove two wing nuts securing the control panel assembly to the cabinet. It is possible at this point to partially remove the control panel. (The panel is hinged and can be moved outward in order to expose the underside. The switches are now accessible for servicing.

To replace an LED switch:

- Remove all wires from the suspected switch.
- Turn the switch counterclockwise while holding the cone-shaped nut on the outside of the game cabinet.
- Install a new switch using the reverse procedure.
- Reconnect the harness wires.

To replace the Horn or Bell button:

- Remove all wires from the suspected switch.
- Remove four screws that secure the plates surrounding the button to the control panel.
- Squeeze both sides of the switch and pull out.
- Replace the switch using the reverse procedure (switch part number 60-020).

The LED switches and bell button on the back or seat control panel are accessible for servicing when the panel is removed. Unlock and open the coin door. Reach in through the coin door and remove the two wing nuts as shown in Figure 3-11. Remove the control panel and follow the same procedures as described for replacing the switches and button on the front control panel.

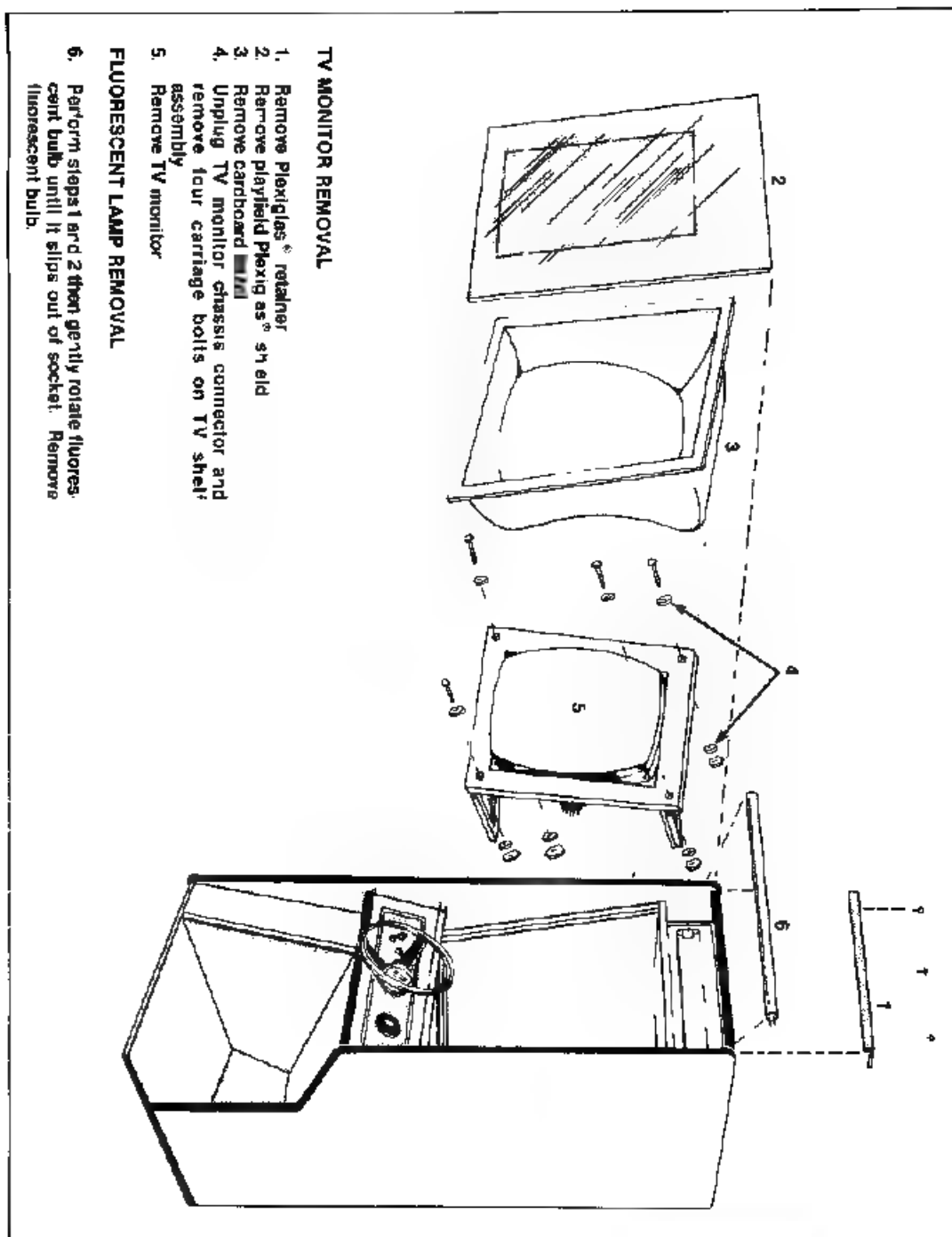


Figure 3-10 TV Monitor and Fluorescent Lamp Removal

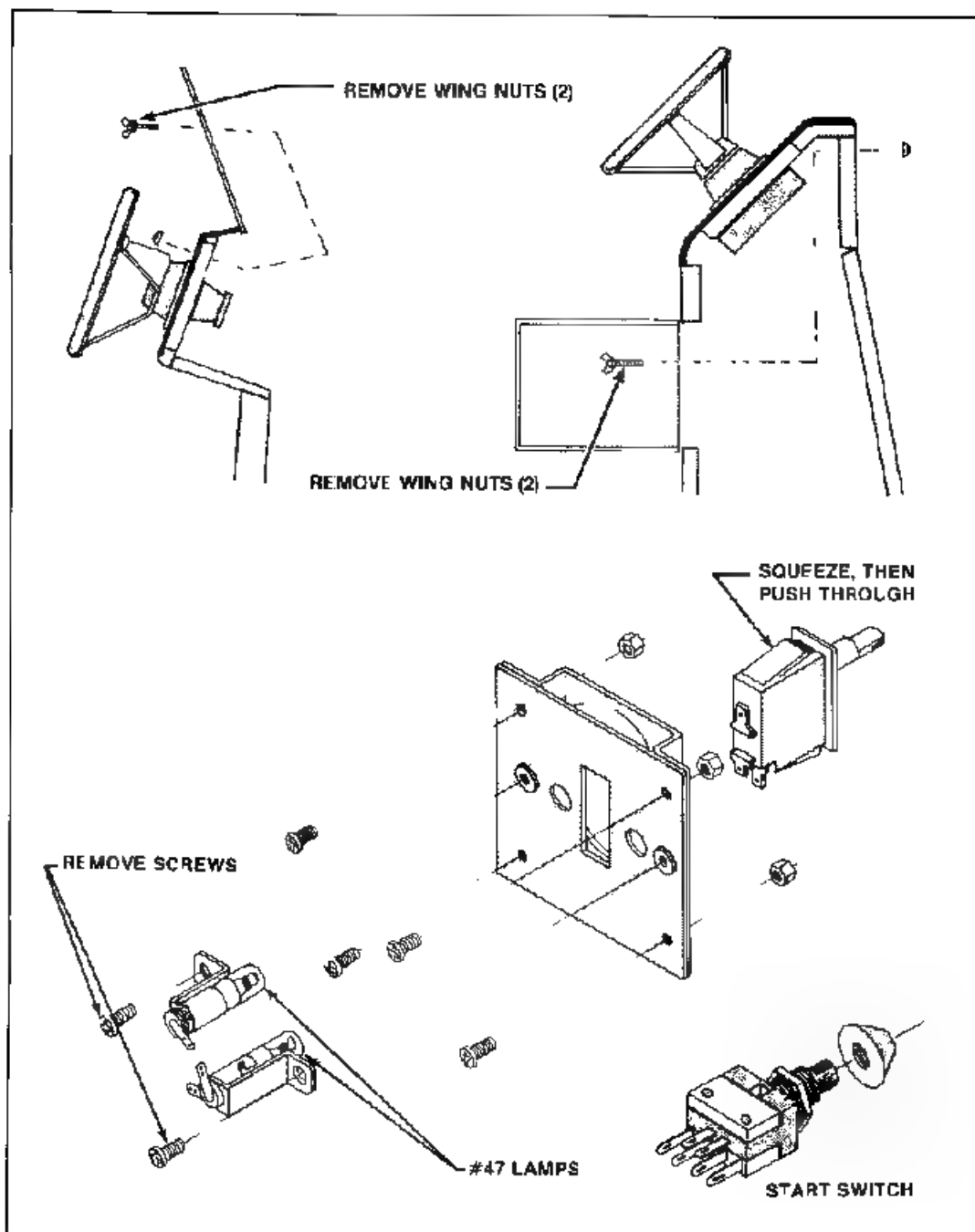
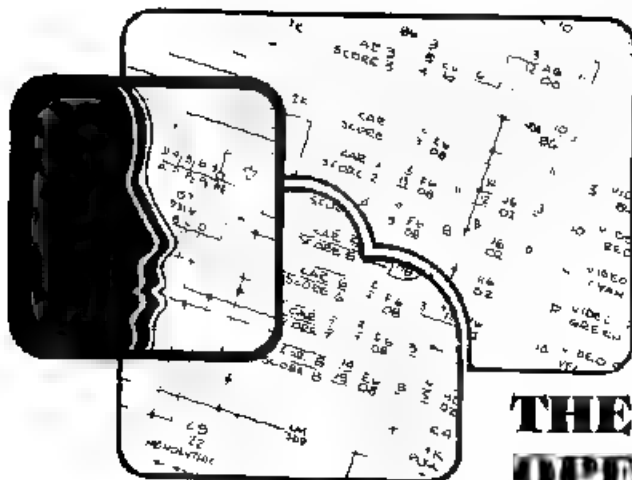


Figure 3-11 Switch and Button Replacement

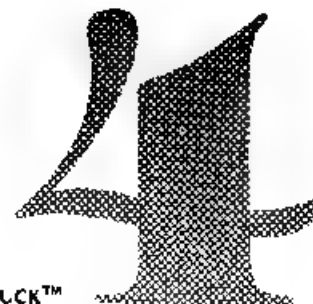


THEORY OF OPERATION

A. GENERAL INFORMATION

The PCB block diagram of Figure 4-1 illustrates the major circuit blocks and their related controls either on the board or remote. The input/output lines are also shown. Figure 4-2 is a general overview of the Fire Truck game.

The game has a solid state self-contained television monitor which produces a picture quite unlike that of your home television screen. For example, the broadcast signal arriving at your home television set is translated into a different video level as compared to the game video signal from the PCB. The sound is generated by logic located on the PCB.



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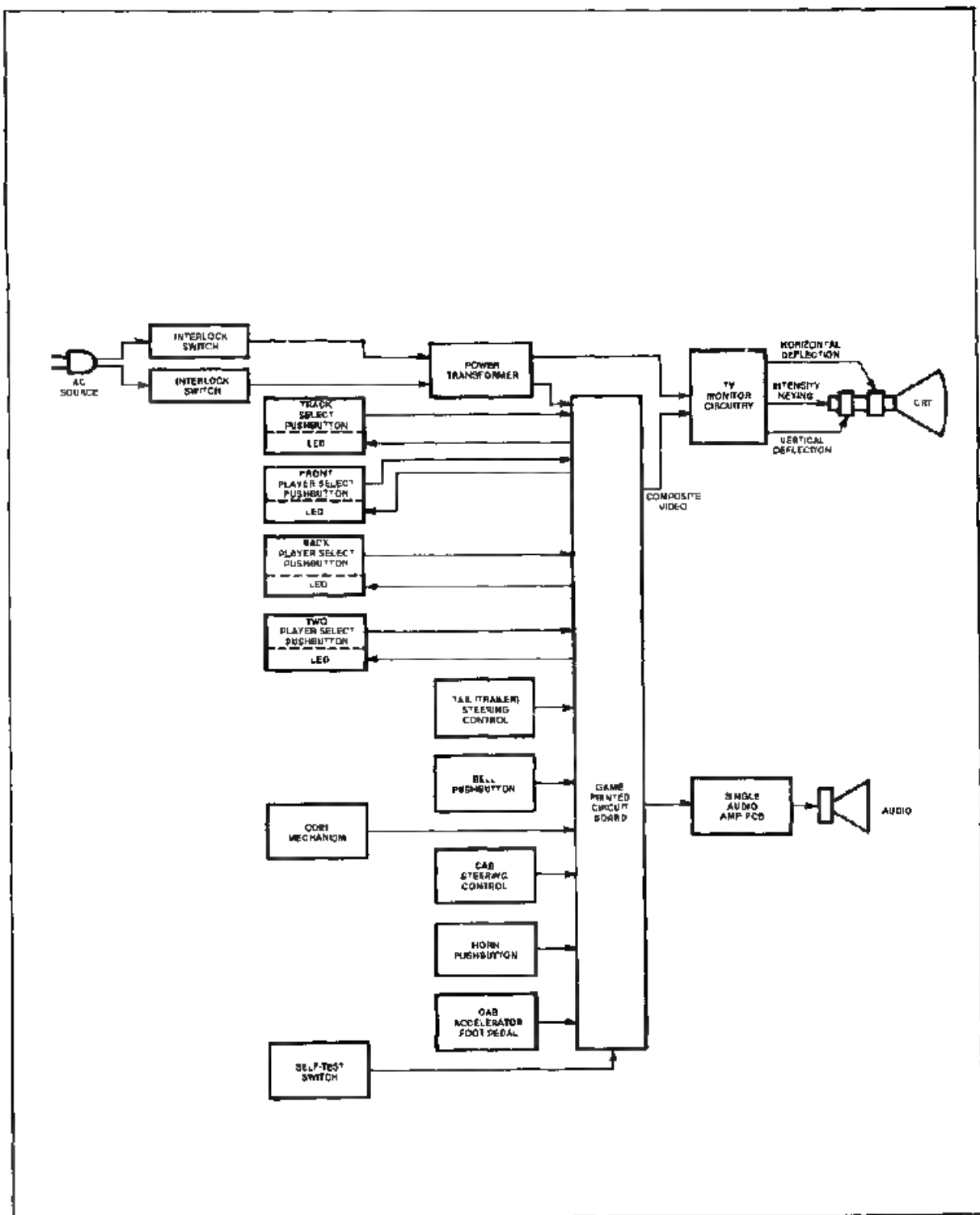


Figure 4-1 Functional Block Diagram of Fire Truck Game

Figure 4-2 Block Diagram of the Fire Truck PCB

The composite video signal from the PCB is comprised of only four video levels instead of the more or less continuous shades of grey seen on a home television screen. The background of the picture is black video and the game objects are grey and/or white video levels.

On the game PCB schematic diagram of Figure 4-4 the symbol \overline{P} (appearing at various inputs of integrated circuit devices) indicates a connection of +5 volts DC through a pull-up resistor.

For easy location reference, the board is divided into sections. These sections are identified by letters A through R, skipping letters C, I, O, and Q because they may be easily confused with numbers 6, 1, and 0 respectively, across the short side of the PCB. Sections are identified along the long side of the PCB by numbers 1 through 11. The letters and numbers create a grid, and all ICs are located on the PCB along the grid lines.

An LM323 regulator is mounted in a large black heatsink and next to it is a 4-ohm, 10-watt resistor. These components produce a great deal of heat during normal operation. The temperature is not extreme, but sensitive skin may burn to the touch.

The harness schematic of Figure 4-3 illustrates how all the electrical and electronic assemblies electrically connect.

B. POWER SUPPLY (See Figure 4-4, Sheet 1 of 6)

The PCB receives +10 volts unregulated from the type B power supply chassis. This raw +10 volts DC is then regulated by an LM323 three-terminal device to a stable +5 volts DC. The +5 volts DC is distributed throughout the board to power all of the Fire Truck PCB logic. At the top of the PCB, most of the wide traces are DC ground. On the back of the board the wide trace along the long end of the PCB is 5 volts DC.

C. CRYSTAL-CONTROLLED OSCILLATOR AND TV SYNC GENERATOR (See Figure 4-4, Sheet 1 of 6)

The crystal-controlled oscillator generates a 12-MHz clock frequency, specifically, 12.096 MHz, that is used to produce all of the operating frequencies required of the game PCB.

The oscillator output (12 MHz) is divided by the divide-by-two to develop two 6-MHz signals (designated

as 6 MHz and $\overline{6\text{MHz}}$). The horizontal sync counters N9 and N10 are driven at 6 MHz, which provide the horizontal synchronizing pulses 1H through 256H. The signals HBLANK and HSYNC are developed in a 4-bit flip-flop P9. HSYNC is the clock input for the vertical counters which provide the vertical synchronizing pulses 1V through 128V. VBLANK and VSYNC are developed by a special coded ROM (read-only memory) at R4.

The horizontal and vertical synchronization signals are used to produce a TV monitor raster made up of 262 horizontal lines at a frequency of 15.750 (256H). Synchronized with line 240 is a vertical blanking pulse that occurs for the duration of 22 more horizontal scans, resulting in the total number of 462 lines per frame.

D. MICROCOMPUTER

The microcomputer consists of read-only memory (ROM), random access memory (RAM), and a microprocessor. The microprocessor controls the microcomputer operations through a 16-bit address bus which addresses the program ROMs. Address lines BA0 through BA7 are also multiplexed with data signals to address the playfield and aphanumeric RAM. An 8-bit bidirectional data bus provides a path for transferring data between the microprocessor and the various memories. A special watchdog circuit makes certain that the microcomputer functions properly.

Address lines (BA0-BA10) are buffered to eliminate signal loading. These buffered address lines address the program ROMs (1, 2, L1, L2, M1 and M2 for the 01 version and C1, D1, F1, and H1 for the 02 version). The direct, non-buffered address lines from the microprocessor are A11-A15.

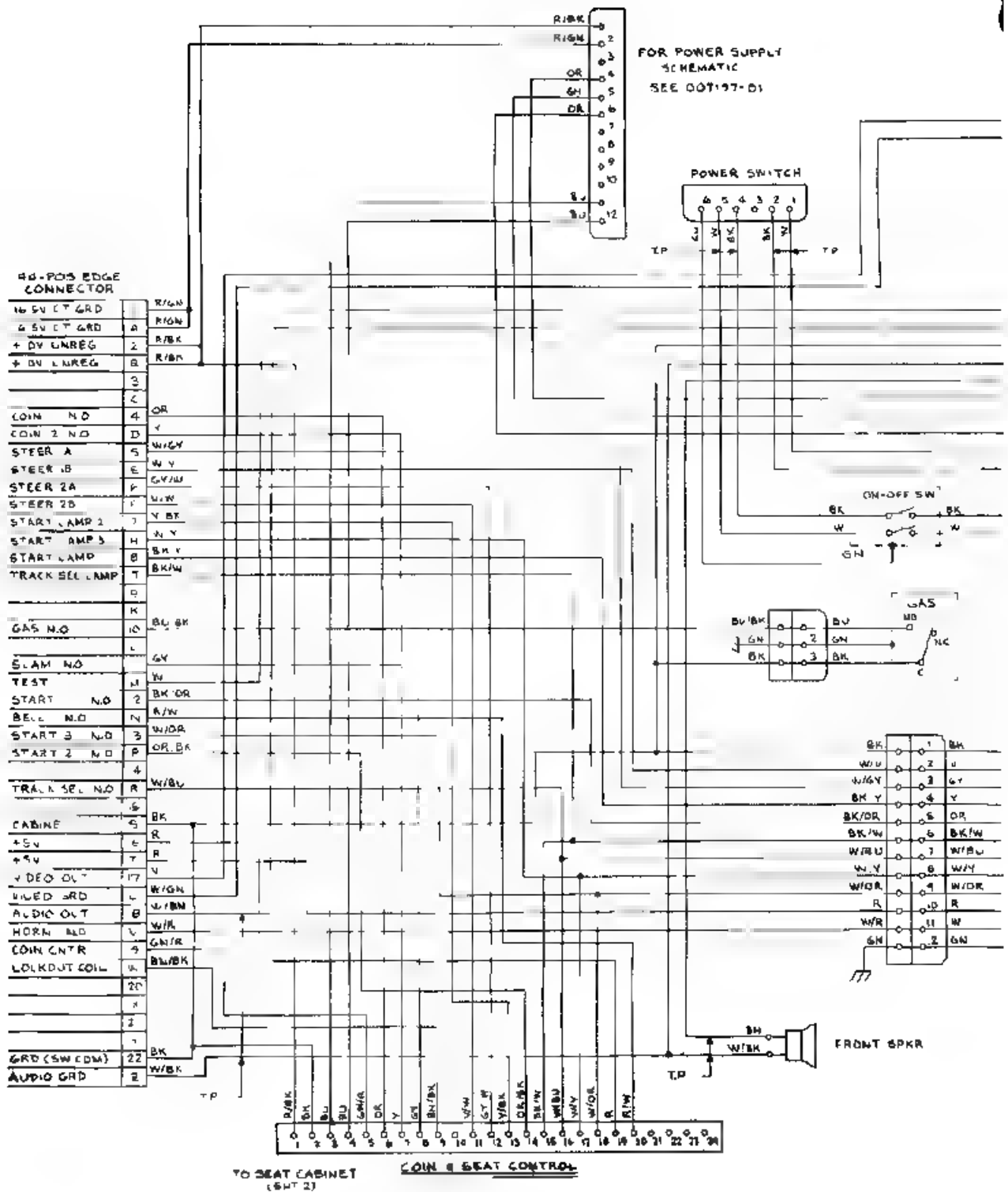
E. MICROPROCESSOR (See Figure 4-4, Sheet 2 of 6)

The 6800 microprocessor (C3) is a bidirectional bus-oriented 8-bit parallel chip with 16 bits of address to select 65K bytes of memory.

To better understand the microprocessor (MPU), refer to Table 4-1 for a complete description of the data address and control lines to the MPU. Only those control lines used are discussed.

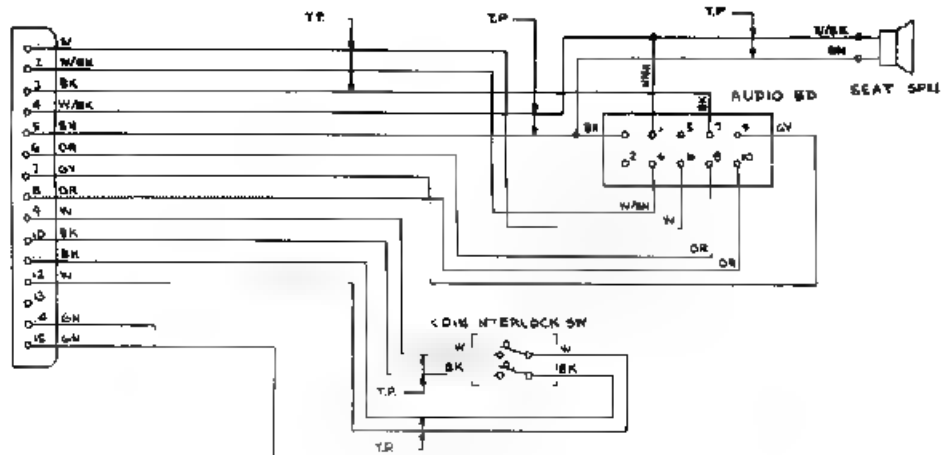
F. MICROPROCESSOR CLOCK (See Figure 4-4, Sheet 1 of 6)

The microprocessor clocks ($\Phi 1$, $\Phi 2$) in this system run at 1 MHz during normal operation and at 750KHz during a self-test sequence. Either of the two frequen-



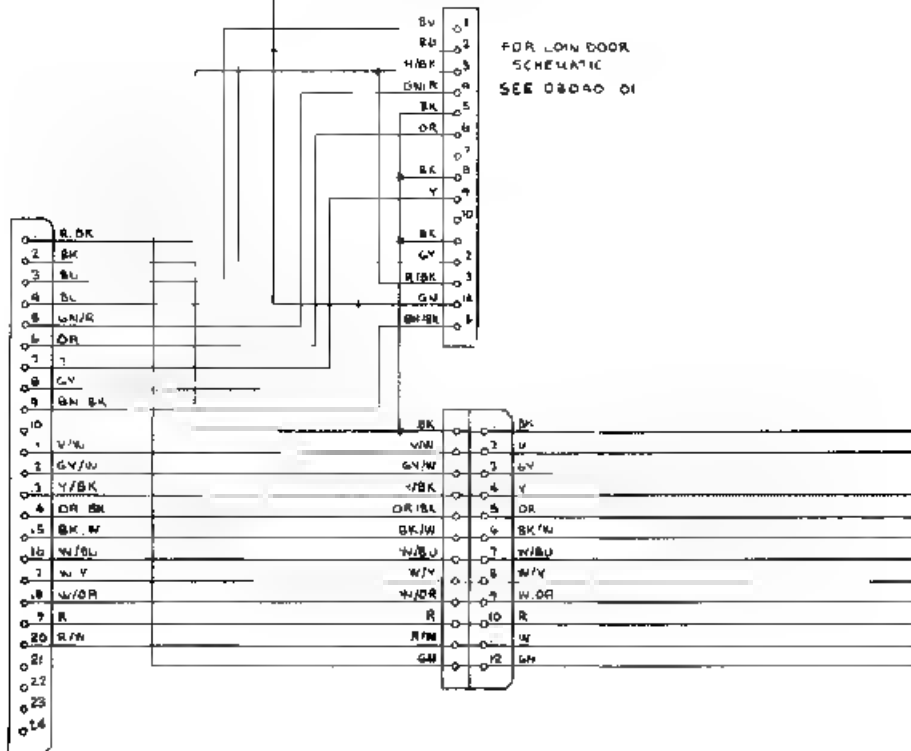
FROM FRONT CABINET
(SHT 1)

AUDIO &
INTERLOCK



FROM FRONT CABINET
(SHT 1)

COIN & SEAT CONTROL



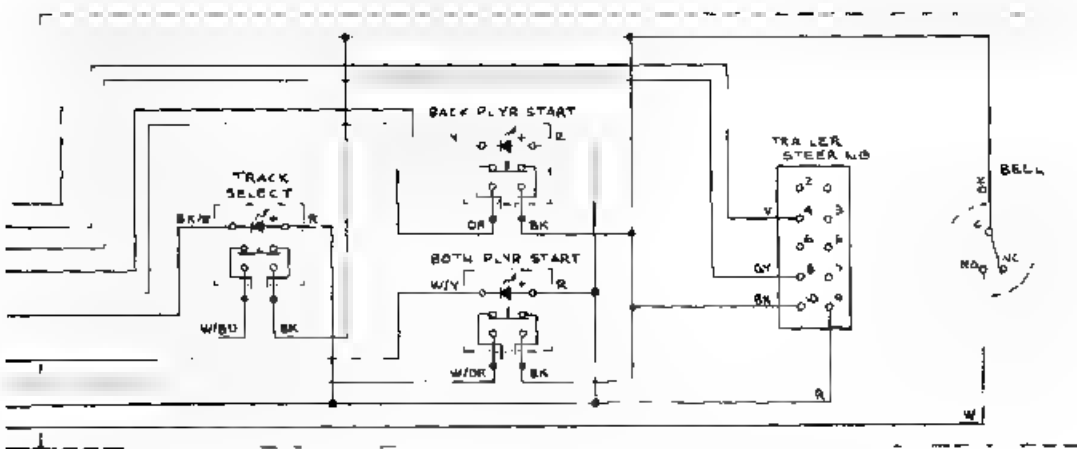


Figure 4-3 Fire Truck Harness Schematic Diagram
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Table 4-1 Microprocessor Signal Descriptions

Signal	Number of Lines	Description, Function
D0-D7	8	These eight lines are bidirectional data bus lines.
A0-A15	16	These sixteen lines are unidirectional MPL address lines to supporting memory (i.e., ROMs, RAMs).
HALT	1	This input is permanently connected to a 1k ohm pull-up resistor.
RESET	1	This input line when low resets the MPL from either a power-down or on a QE output of the watchdog counter. During the reset sequence prior to RESET going high, the contents of the last two locations (FFFF-FFFF) in memory are loaded into the MPL program counter to point the start of a reset routine.
IRQ	1	This input when low indicates an interrupt request to the MPL. After the MPL concludes its current sequence it will then proceed to the IRQ sequence.
NMI	1	This input line when going low indicates a non-maskable interrupt sequence. After the MPL concludes its current sequence it will then proceed to the NMI sequence.
IO/ST	1	This output line when high enables the MPL tri-state bus drivers. It is driven by the $\Phi 2$ clock.
$\Phi 1$, $\Phi 2$	2	Two-phase, non-overlapping MPL clock outputs.
TSC	1	This line is permanently tied to ground.
RAM	1	This output is the read and write signal line for the RAM memory. It normally is in the read (R) or high state.

cies are enabled when the TEST signal changes logic state at pin 1 of Data Selector F7.

When the TEST signal is high, the trailing edge of the 2Mhz B signal generated by flip-flop J8 (on sheet 1 of 6), is selected to clock the K flip-flop D5. The game is in the normal operation as illustrated in timing diagram Figure 4-5a.

When the TEST signal goes low, the game is in the self-test mode which requires a 750Khz clock. This clock is generated by selecting the 2B input to F7; this input clocks the D5 flip-flop dividing it down to 750Khz as illustrated in timing diagram Figure 4-5b.

A positive $\Phi 1$ changes the microprocessor address and data lines. A positive $\Phi 2$ enables the microprocessor to address memory and input/output data onto the data bus.

G. MICROPROCESSOR WATCHDOG (See Figure 4-4, Sheet 2 of 6)

Watchdog is an external monitoring system that resets the program execution back to its initial sequence. This is accomplished by a watchdog statement incorporated in program memory that results in a WATCHDOG RESET pulse at the output of the address decoder.

The watchdog circuit is a 5-bit shift register. In normal operation the circuit is pulsed once each TV picture frame by the VBLANK pulse. If five frames occur without a WATCHDOG RESET pulse, the counter resets the microprocessor. This prevents random electronic static from upsetting game operation. The power-on circuit or the hardware for reset presets the counter, which in turn initializes the microprocessor and starts the attract sequence.

H. ALPHANUMERIC GENERATOR (See Figure 4-4, Sheet 3 of 6)

Alpha characters and numerals are stored in ROM R3. Each character is traced in a block 16 lines square. The RAMs are shared between the microprocessor and the horizontal H₁ and vertical V₁ sync pulses. Data selector devices N1 and P1 select the desired addressing mode. Hardware addressing is accomplished when the HRDWR line is low and the 4H pulse is low. This produces the A/N SEL signal for devices N1 and P1. The hardware data V₁ and H₁ sync pulses address the RAMs when A/N SEL is High.

If the microprocessor tries to access the RAMs when the HRDWR signal is low, the STPCLK signal stops the microprocessor clock when the hardware signals display the ROM alphanumeric. These alphanumerics are displayed at the left and right of the TV screen.

A high HRDWR signal returns the RAM addressing to the buffered address lines (BA0-BA7). The RAM uses data lines (BD0-BD7) when the buffered address lines are addressing the N2 and P2 RAMs. This continues until the next hardware addressing sequence.

The output of the alphanumeric ROM R3 is converted from 4-bit parallel type to a serial output and clocked out to the summing gates through shift register L3 as the A₁N VIDEO signal.

I. PLAYFIELD GENERATOR (See Figure 4-4, Sheet 3 of 6)

The playfield generator is similar in operation to the alphanumeric generator. The ROM (F5) is either addressed by the RAMs (J4-H4) or the microprocessor. The RAMs are addressed by either the position counters E3-E4 or by the buffered address line BA0-BA7.

When the PRAM signal goes low at the data selectors H3 and J3, it selects the playfield horizontal and vertical position signals (PHP/PVP). The PHP and the PVP lines are generated by the buffered data outputs of the

microprocessor. When the PRAM line goes high the buffered address lines are selected and the ROM is addressed. The address interchange is never interrupted, providing a continuous playfield. The output of the playfield ROM F5 is converted from 8-bit parallel to serial output. It is clocked out to the summing gates through shift register L5 as the signal.

J. CAB VIDEO GENERATOR (See Figure 4-4, Sheet 4 of 6)

The cab video PROM (programmable read-only memory) P7 contains cab video display data. The cab is rotated by inverting the horizontal and vertical signals and then swapping them at the PB-N7 and R7 data selectors. The outputs CH and CV of the data selectors provide a 24 rotations of the cab. The PROM is addressed and the cab video display data is outputted to device M7. The cab video signal is then ORed with the tail display data prior to the video summing gates.

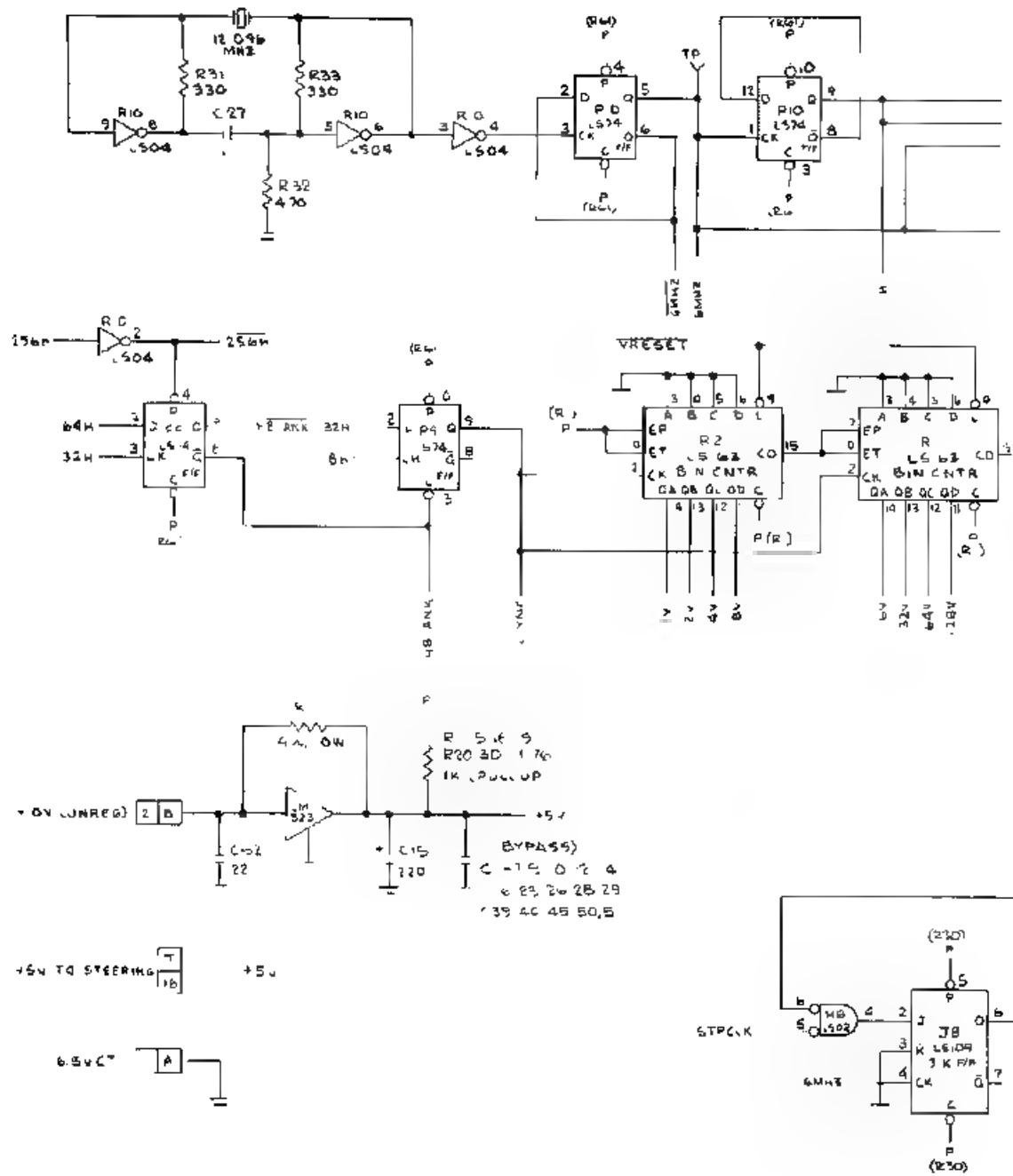
K. TAIL VIDEO GENERATOR (See Figure 4-4, Sheet 4 of 6)

The tail video ROMs J5 and L5 contain the tail video display data. This data is selected by the X and Y outputs from the sync rotation counters K3-L3, K4 and L4 at the ROM address inputs (A0-A10). The tail video display is rotated by either the up or the down counting of the rotation sync counters that provide a total 24 rotations to the tail. The Q outputs of M5 are then enabled and the M6 eight-to-one data selector generates the signal to be ORed with the cab video display data prior to the video summing gates.

L. STEERING CONTROL LOGIC (See Figure 4-4, Sheet 5 of 6)

Steering STEER 1A, 1B, 2A, 2B) information for both the cab and the tail is "looked" for by the microprocessor (C3) during the play mode. The steering PCB assembly consists of two light-emitting diodes that are optically aligned with two light-sensitive transistors. A toothed cylinder (turned by the steering wheel) is inserted between the light-emitting diodes and the transistors and it interrupts the light from the diodes.

When the steering wheel is turned, two pulses appear at the output of the steering PCB assembly that differ in phase as illustrated in Figure 4-6. When the wheel is turned to the right, the A output pulse leads the B output pulse. When the wheel is turned to the left, the A output pulse lags the B output pulse. The inverse of the

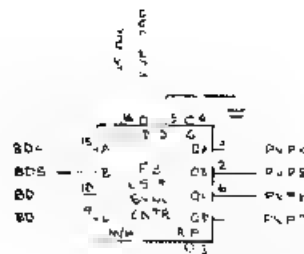
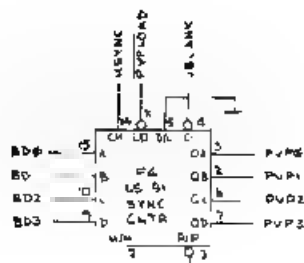


3B FIRE TRUCK™



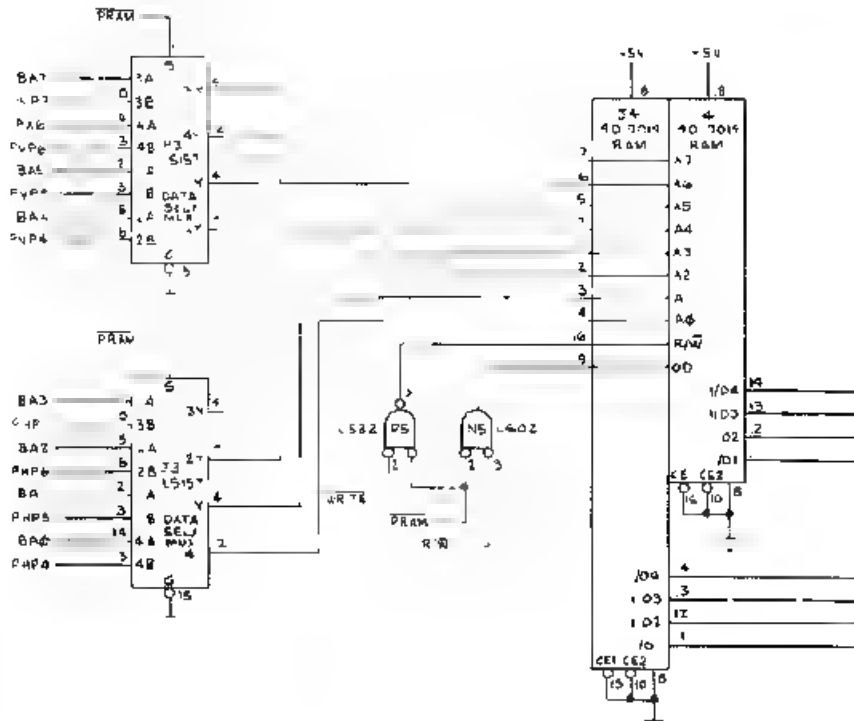
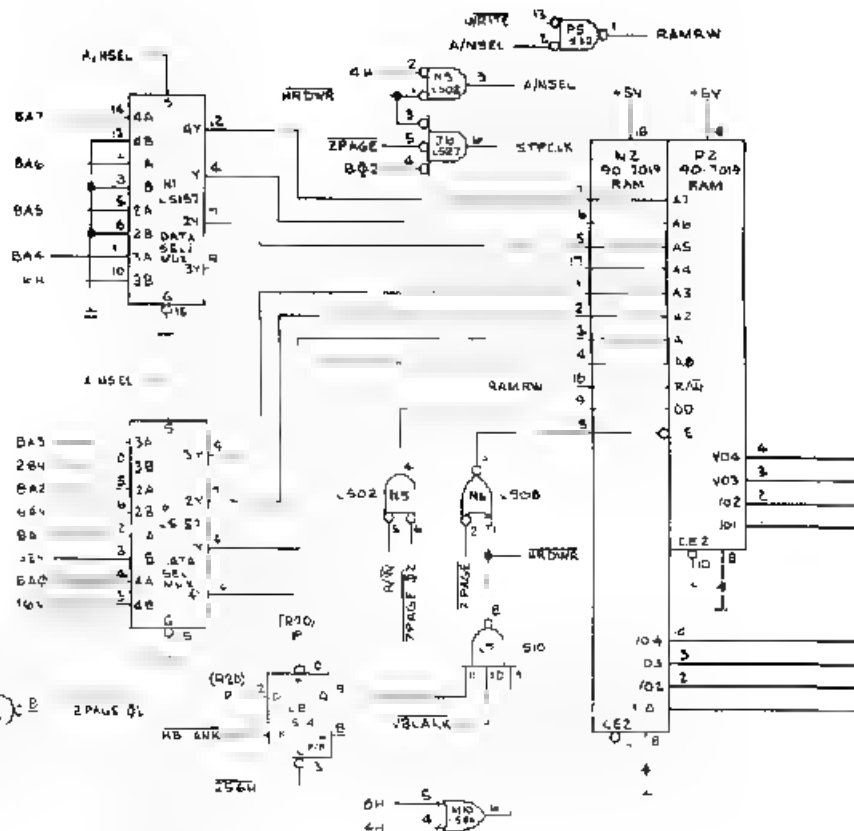
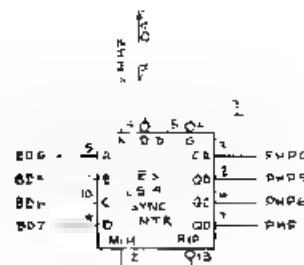


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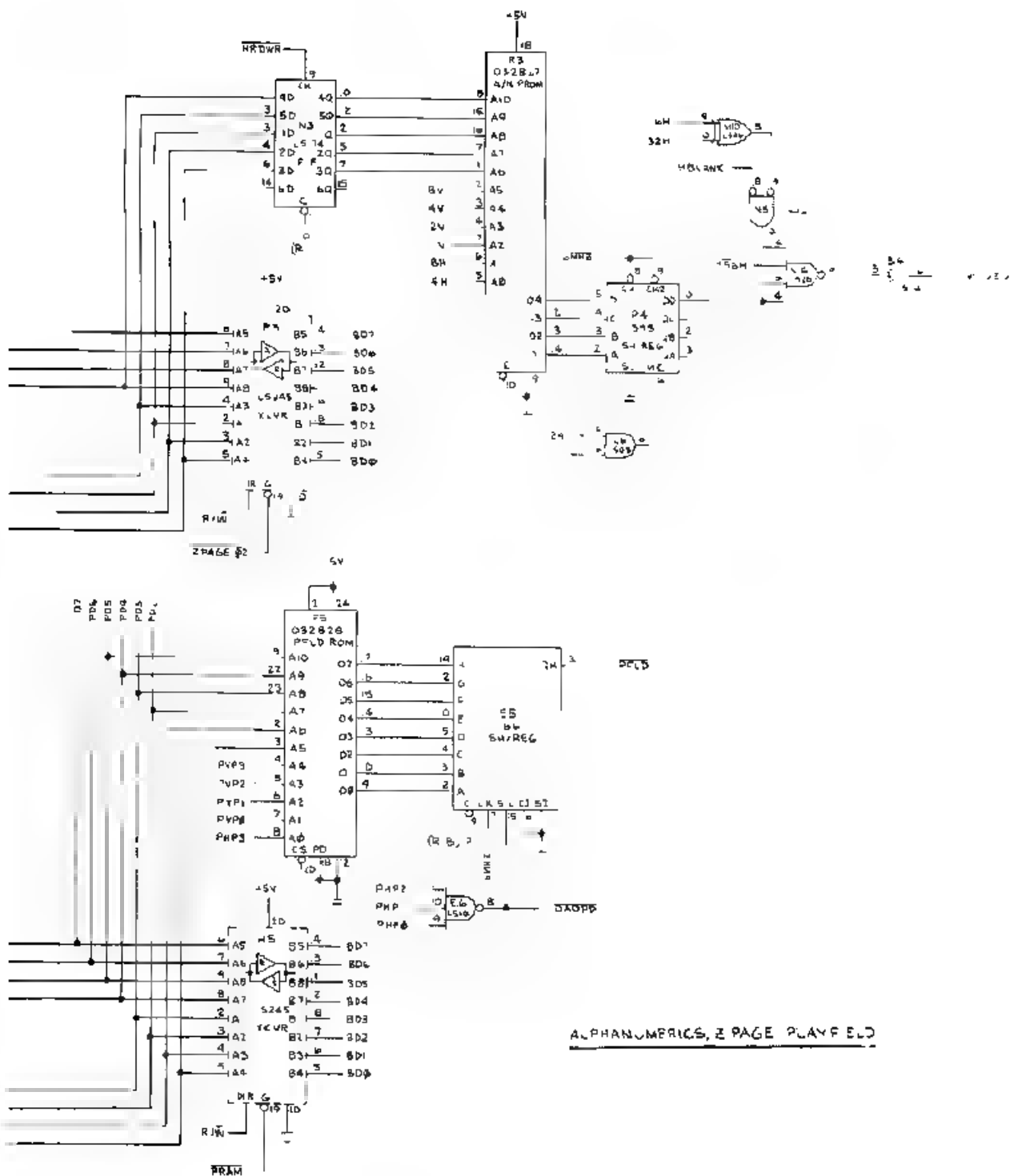
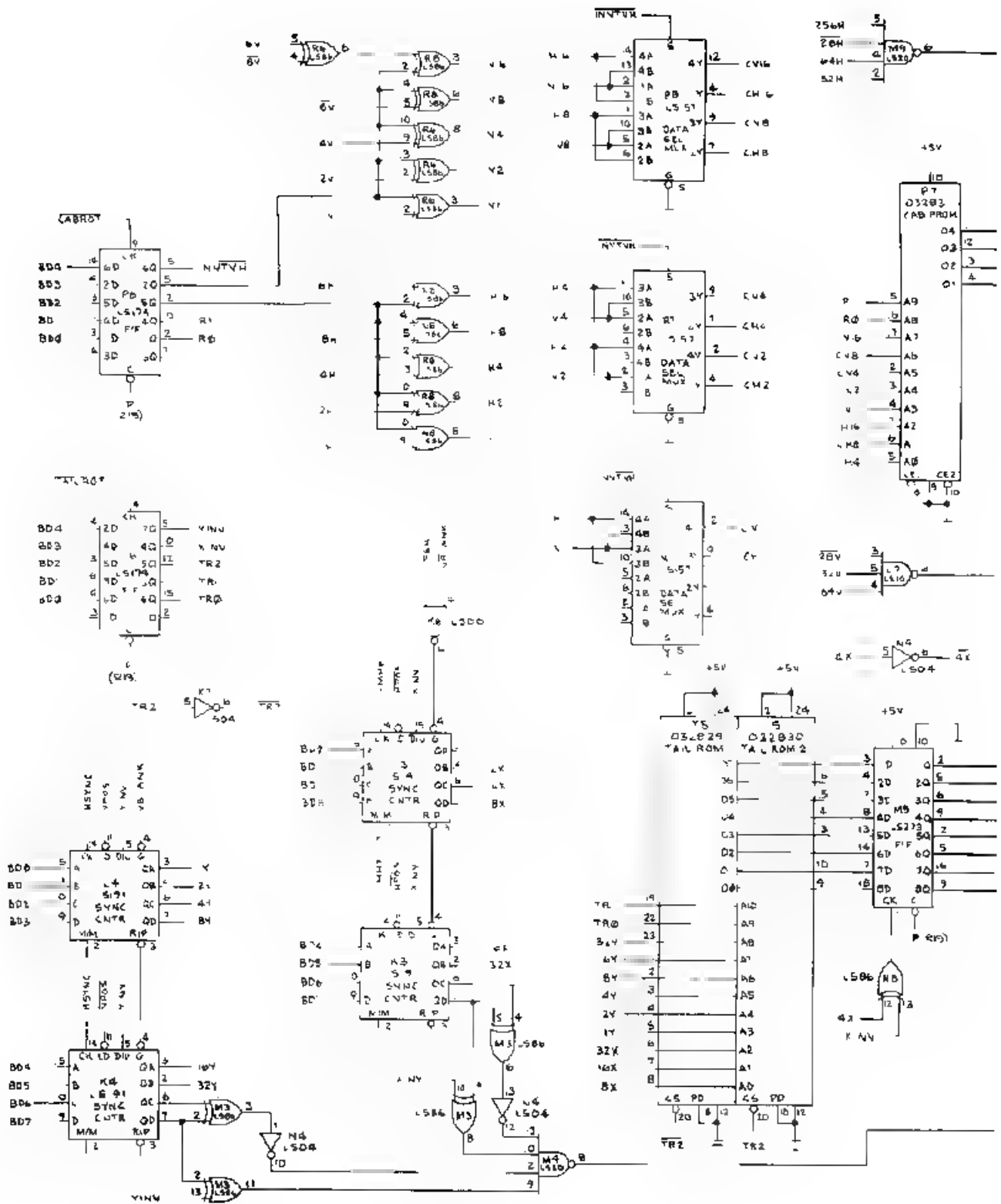


Figure 4-4 Fire Truck PCB Schematic Diagram Sheet 3 of 6 030926



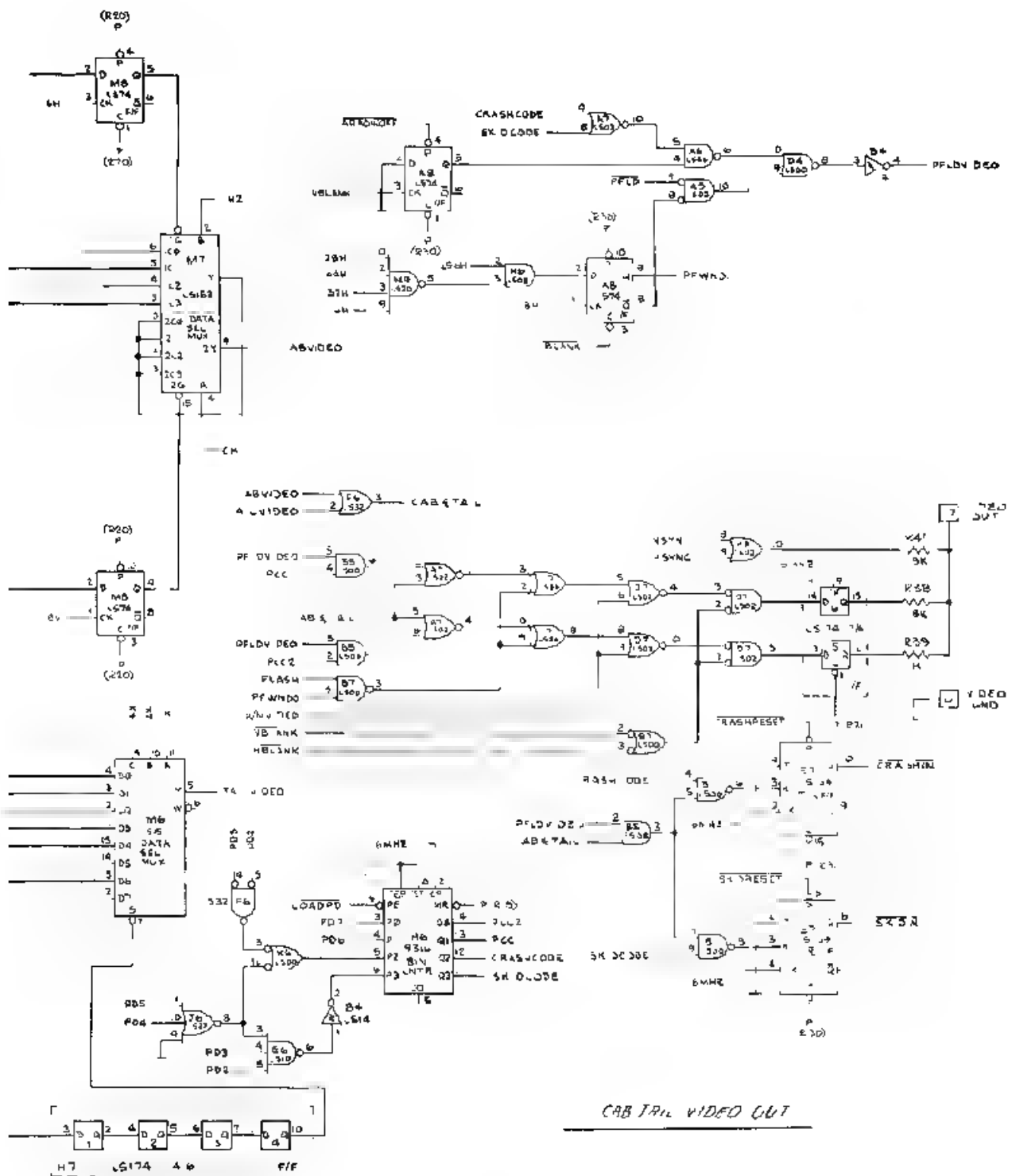
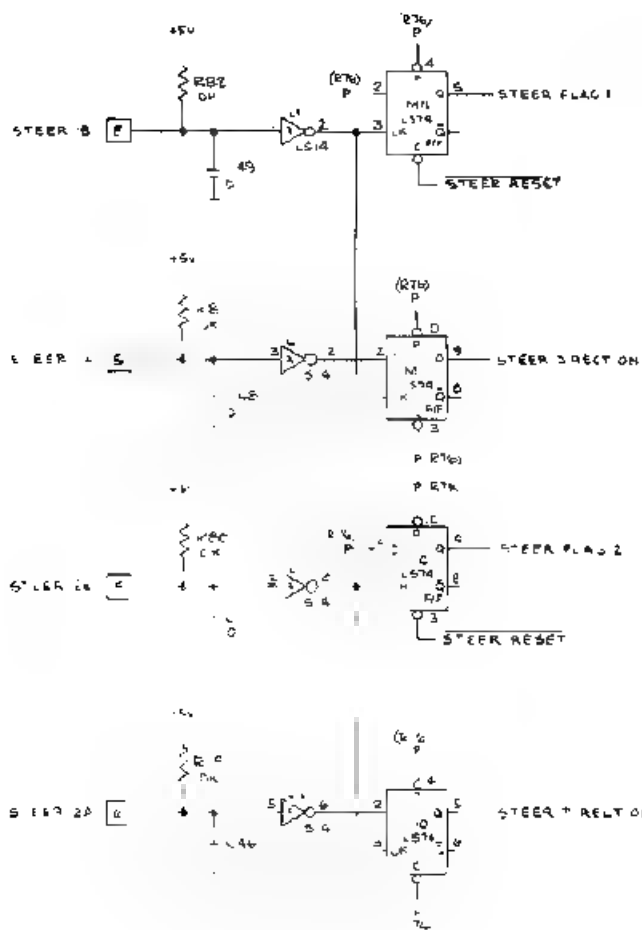


Figure 44 Fire Truck PCB Schematic Diagram Sheet 4 of 6
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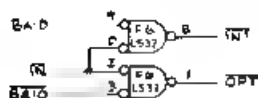
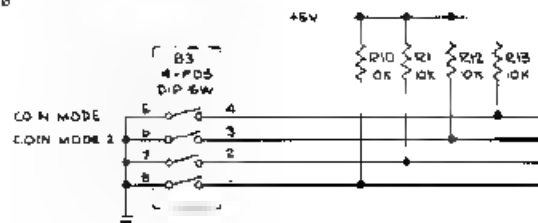
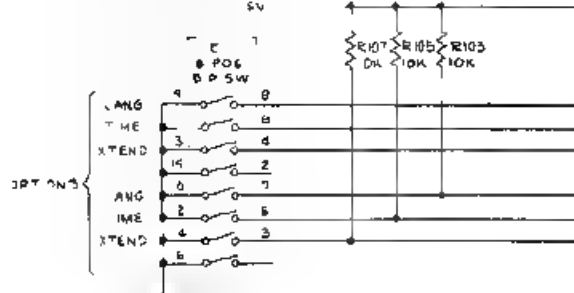
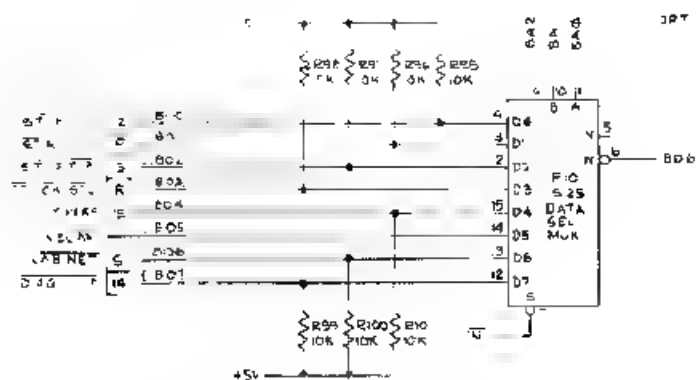
SPARE ☐ L B00?
 SPARE ☐ L B01?
 STEER FLAG 1 ☐ L B01?
 STEER FLAG 2 ☐ L B02?

CRASH ☐ L B00?
 DIAG STEP ☐ L B01?

COIN 2 NO ☐ L B03?

COIN 1 NO ☐ L B04?

SPARE ☐ L B00?
 GAS ☐ L B01?
 STEER D RECT ON ☐ L B02?
 STEER D RECT ON 2 ☐ L B03?
 BELL ☐ L B04?
 CLARK ☐ L B05?
 BRITAIN ☐ L B06?
 TEST ☐ L B07?



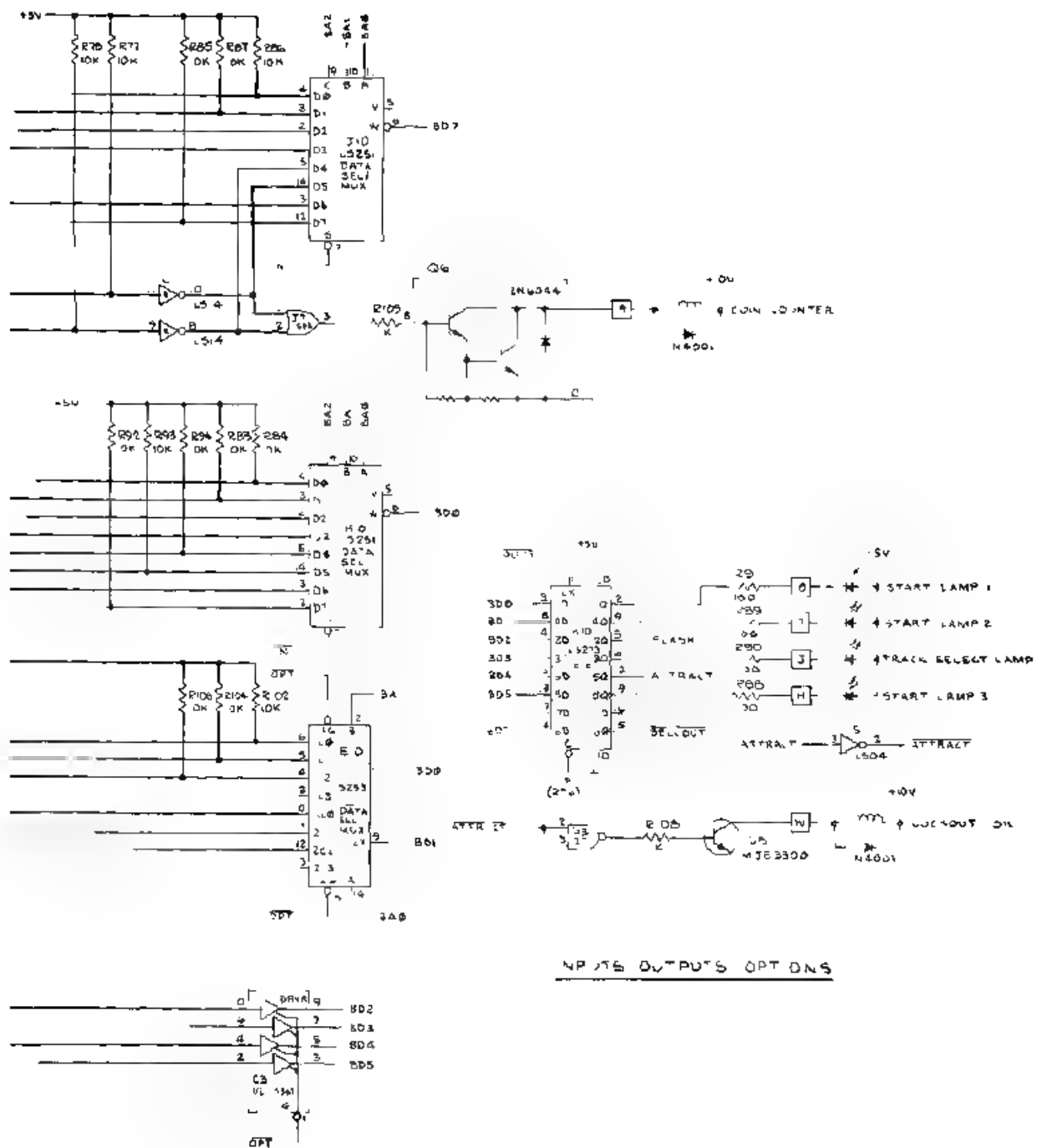
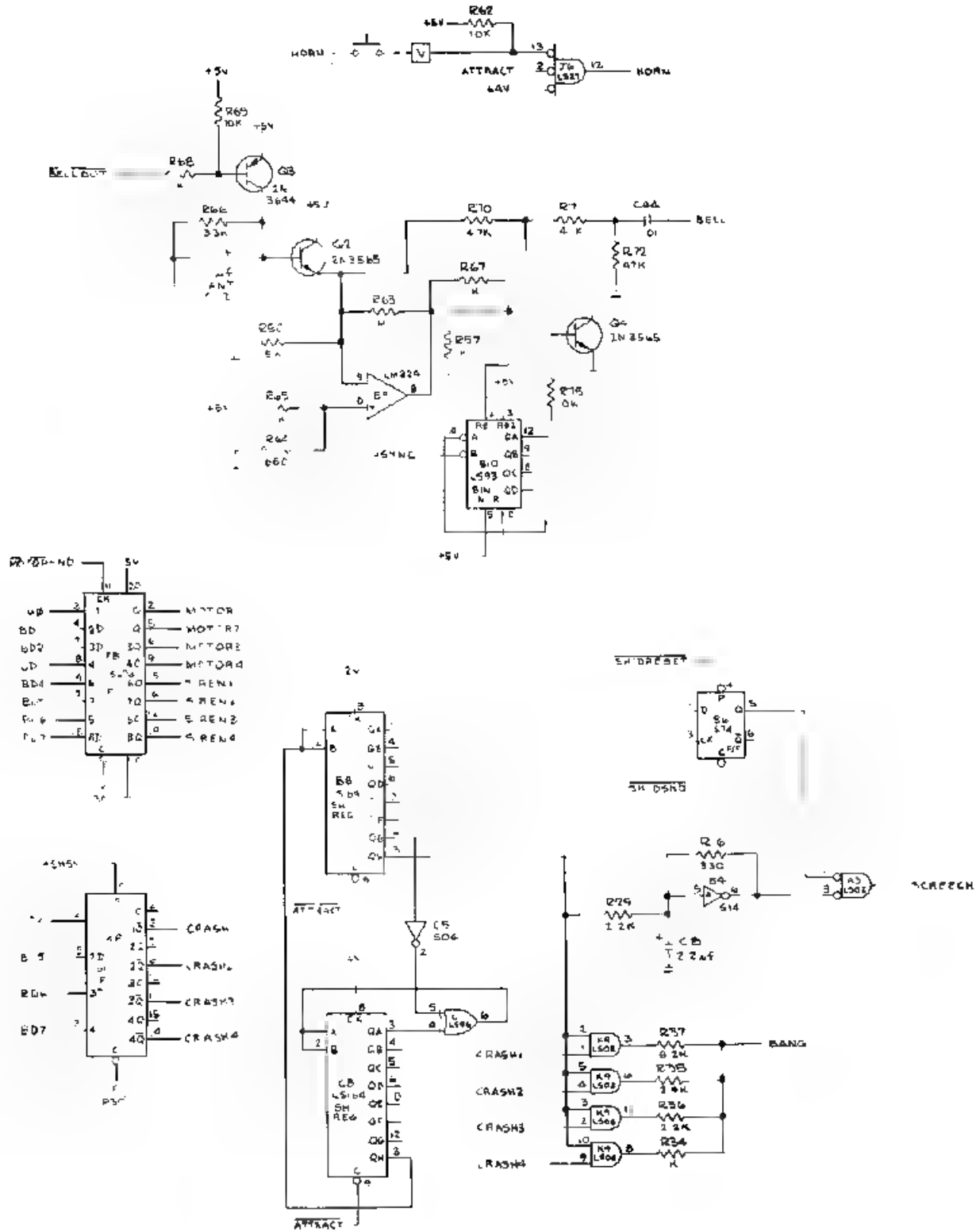


Figure 4-4 Fire Truck PCB Schematic Diagram Sheet 5 of 6



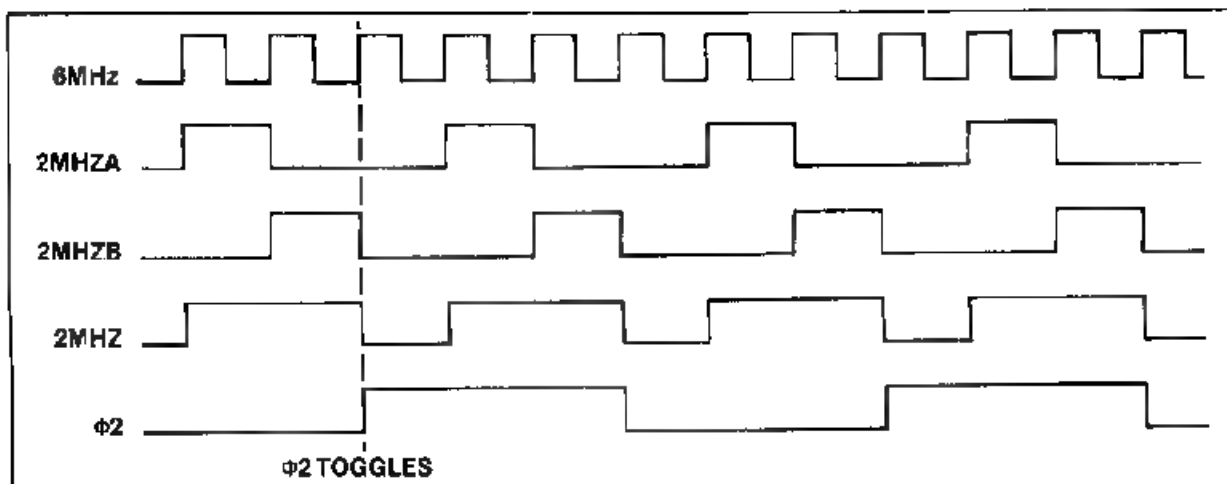


Figure 4-5a 1MHz Timing Chart (Normal Operation)

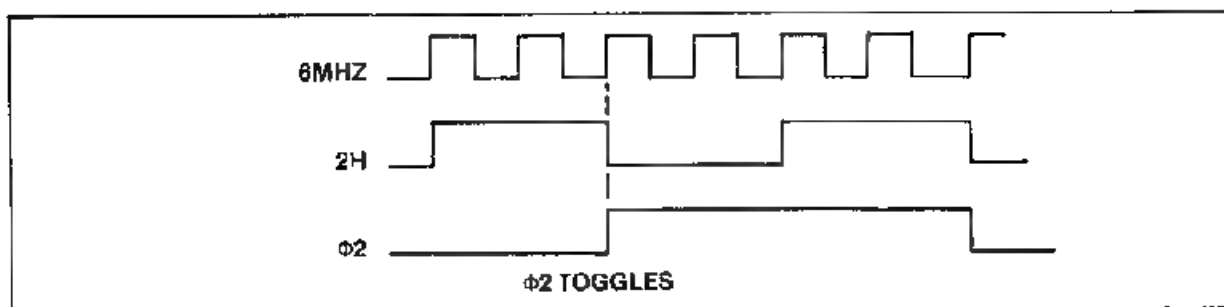


Figure 4-5b 750 KHz Timing Chart (Self-Test Only)

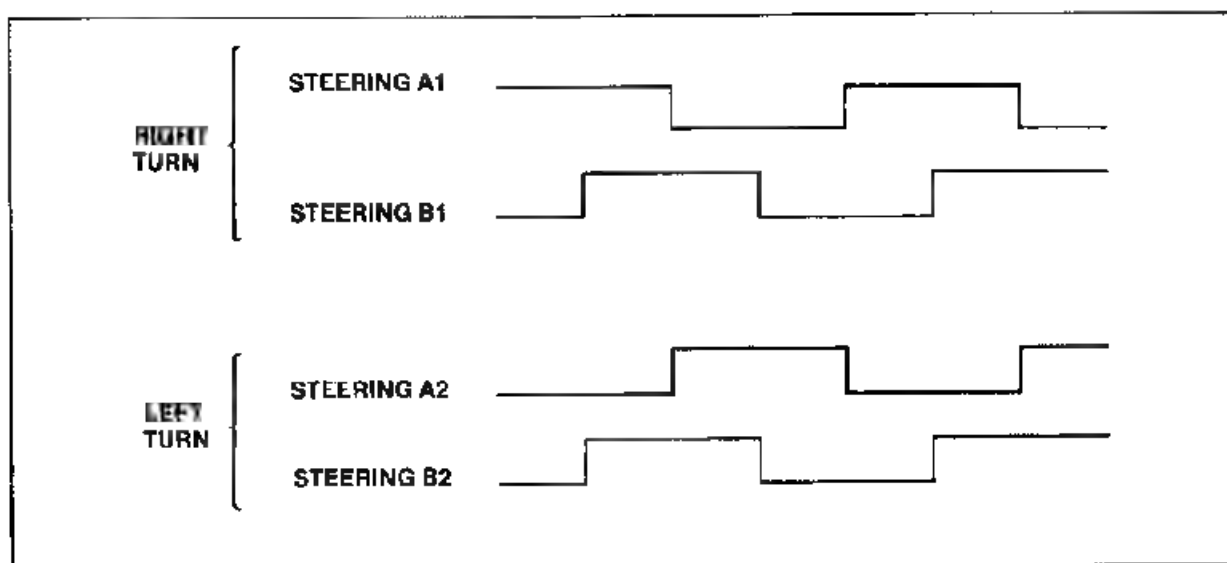


Figure 4-6 Steering Printed Circuit Assembly Output Pulses

two pulses are applied to the D and clock inputs of the D-type flip-flops.

The MPU recognizes that a steering maneuver has been made when a low appears on data line BD7. The MPU then looks at the data line BD0 and determines from the logic level (high or low) whether the turn is left or right. Once the MPU has processed a steering maneuver, the MPU then outputs an address that is decoded by the address decoder and results in a low STEERING RESET signal. This signal resets the D-type flip-flop responsible for the STEER FLAG signal.

M. HORN AND BELL GENERATOR **(See Figure 4-4, Sheet 6 of 6)**

The horn is manually sounded by pressing a large pushbutton labeled *HORN* at the cab control panel.

The bell is also manually sounded by pressing another large pushbutton labeled *BELL* at the tail (trailer) control panel. This also occurs automatically when points are scored. The bell is disabled by the microprocessor if the game is in the "front player only" mode (trailer is controlled by computer).

N. MOTOR AND SIREN GENERATOR **(See Figure 4-4, Sheet 6 of 6)**

The key to the motor generator is the operation of transistor Q1 in conjunction with timer B9. Timer B9 operates as an oscillator with its output frequency dependent upon the collector voltage of Q1. This voltage is the result of the base voltage selected at the MOTOR 1, 2, 3, or 4 input lines.

As the Q1 base voltage increases, so does the charging voltage at the collector across capacitor C25. This VCO control voltage sets the VCO circuit at a frequency selected by the buffered data lines; the voltage is adjustable by setting pot R27. The VCO output is divided into two separate frequencies by the divide-by-twelve device A9 and is then summed by resistors R73 and R74. This produces a realistic motor sound as the player shifts gears.

The siren generator is similar to the motor generator. The control voltage to the VCO is generated by voltage levels present at resistors R45, R46, R47, R48 that drive voltage to power E9. The output of E9 is the

control voltage that controls the output frequency of timer B9.

O. BANG AND SCREECH GENERATOR **(See Figure 4-4, Sheet 6 of 6)**

The heart of the bang and screech generator is the noise generator comprised of 8-bit shift registers B8, C8. These two devices are connected in a manner to produce random noise at the QH (pin 13) output of B7.

The bang is the result of data (BD4-BD7) from the microcomputer; the data is used to gate varying amounts of random noise through to the audio amplifier. Starting with binary data code 1111, then rapidly stepping the data code down to 0000 results in gating noise from noise generator B8, C8 through a resistive value of 550 ohms (R34, R35, R36, R37 in parallel) to 8.2K ohms for a data code of 0001, and infinity for a data code of 0000. The result is an envelope from full on to full off.

The screech sound is produced by processing the output of the random noise generator with a type of hysteresis feedback loop comprised of Schmidt trigger inverter B4 (7414). This processed noise is gated to the audio summing network each time SKDSND goes low and clears the B6 flip-flop.

P. AUDIO OUTPUT **(See Figure 4-4, Sheet 6 of 6)**

All the processed sounds (i.e. siren, motor, horn) are summed at the inverting input of op-amp E9. The output of E9 is then amplified by the single audio circuit. This circuit is not located on the Fire Truck PCB.

Q. SINGLE AUDIO AMPLIFIER **(See Figure 4-7)**

The single audio amplifier for Fire Truck is the 01 version assembly which uses only one of the audio amplifier circuits. The audio output (pin 18 of the Fire Truck PCB) from op-amp E9 is amplified and matched to an 8-ohm speaker. The audio level (volume) is adjustable by rotating the R2 potentiometer located on the Single Audio Amplifier PCB.

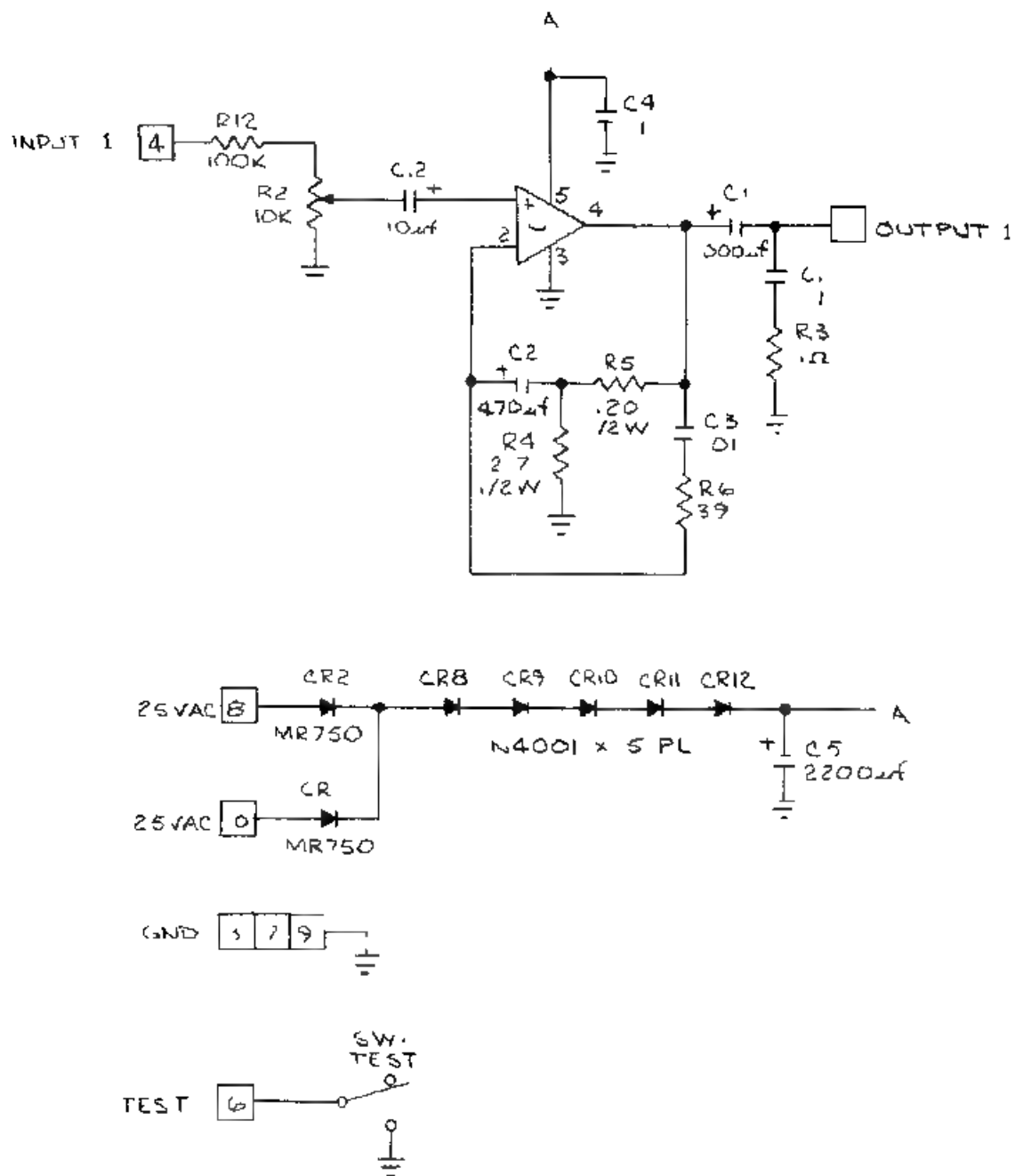
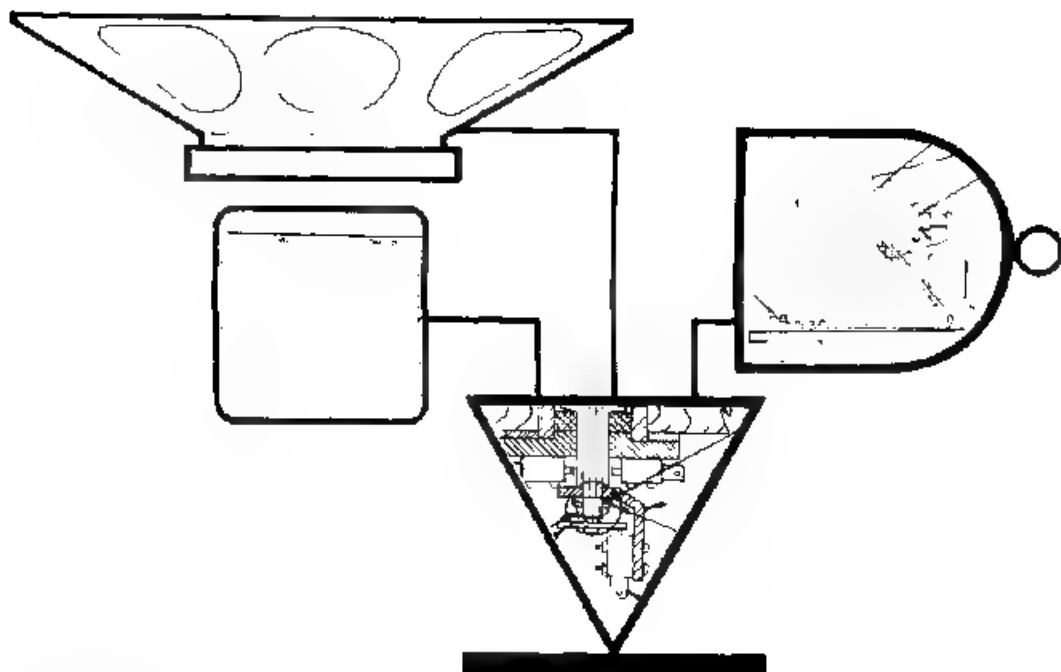


Figure 4-7 Single Audio Amplifier PCB
A009574-01 B



ILLUSTRATED PARTS CATALOG

The purpose of this chapter is to provide you with the necessary information for ordering replacement parts for the Fire Truck game.

When ordering parts from your distributor, give the part number, part name, applicable figure number of this catalog, and the serial number of your Fire Truck game. This will help to avoid confusion and mistakes in your order. We hope the results will be less downtime and more profit from your game.

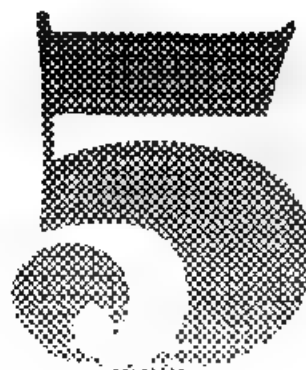




Figure 5-1 Final Cabinet Assembly
Parts List

Item	Part Number	Qty.	Description
1	A032756-02	1	Assy., Cabinet Wood w/Graphics
2	A032747-01	1	Assy., T.V. Monitor
3	A032757-01	1	Assy., Main Control Panel
4	A006917-05	1	18" Inch Fluorescent Light Assy
5	A009569-01	1	Final Assy., Foot Pedal
6	A007197-01	1	Power Supply Assy Type B
7	A030867-01	1	Assy., R.F. Shield Enclosure
8	A030928-01	1	R.F. Shield PCB Assy
9	A030927-01	1	Main PCB Assy
10	A033016-01	1	Strain Relief Power Cord Assy
11	A032855-02	1	Main Harness & Switch Assy
12	012854-01	Ref	Harness Schematic
13	46-201202	2	Fuse, 5 AG Slow Acting 2 AMP
14	030952-01	1	Plex Retainer
15	030955-01	1	Plex Screen W/Graphics
16	032755-01	1	Bezel w/Graphics
17	002728-01	2	BRK., Panel MTG.
18	000869-01	1	Speaker Grill
19	48-004	1	Speaker 5" Arkayl
20	A032741-01	1	Assy Door Rear W/Lock
21	007103-01	1	On/Off Switch Cover
22	75-07048	4	Torque Washer
23	TM-115	1	Tech Manual
24	ST-115	1	Self Test Chart
25	005233-01	1	Rear Door Seal
26	032760-01	1	Patent Drawing
27	75-99090006	3	Well Nut, Blind Hole Fastener
28	82-8016B	3	Screw, But Hd., Socket #10-32 x 1.00 Blk.
29	75-07021	3	Washer, Flat, Black Nylon, #10
30	75-0155	14	Washer, Flat 1/4"
31	75-045	16	Washer, Split-Lock 1/4"
32	75-935	2	Wing Nut 1/4-20
33	75-915S	12	Nut, Hex 1/4-20
34	75-5532N	4	Bolt, Carriage 1/4 20 x 2.00" Lg
35	75-5516N	4	Bolt, Carriage 1/4 1.00" Lg.
36	72-5532	2	Screw Hex Hd. 1/4-20 x 2.00" Lg
37	73-77004	4	Rivets 3/16 x .68" Lg.
38	72-6812	12	Screw, S.M. Self Tapping #8 x .75" Lg
39	82-1824	4	Screw, Wood #8 x 1.50" Lg.
40	72-6610	8	Screw, S.M. Pan Hd Phil. #6 x 5/8" Lg.

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Figure 5-2 Final Seat Assembly
Parts List

Item	Part Number	Qty.	Description
1	A032715-02	1	Assy., Cabinet Seat W/Graphics
2	A032719-01	1	Assy., Rear Control Panel
3	A009083-01	1	Assy., Final Coin Door
4	A009548-01	1	Assy., Coin Box Lid
5	009549-01	1	Coin Box
6	030717-01	1	Bracket, (Coin Box)
7	002728-01	2	Bracket, Panel MTG
8	48-004	1	Speaker 5" Arkay)
9	000869-01	1	Speaker Grill
10	73-77004	4	Rivets 3/16 x .68" Lg
11	75-5516B	4	Bolt, Carriage 1/2-20 x 1.00" Lg Blk
12	75-0155	13	Washer, Flat 1/4"
13	75-990505S	4	Nut, Lock Shallow Pat. Nylon 1/2-20
14	032721-01	1	Connector
15	75-5520B	9	Bolt, Carriage 1/4-20 x 1.25 Lg Blk
16	75-935	9	Nut, Wing 1/4-20
17	75-045	9	Washer, Split Lock 1/4"
18	72-6812	10	Screw, SM Self-Tapping #8 x 3/4" Lg
19	A032857-01	1	Assy., Seat Harness & Interlock Switch
20	A009574-01	1	Assy., Single Audio Amp Bd
21	72-6610	9	Screw, SM, Pan Hd Phil. #6 x 5/8" Lg.
22	032763-01	1	Silkscreen, Plex-Coin Door
23	032763-02	1	" " " "
24	032763-03	1	" " " "
25	032763-04	1	" " " "

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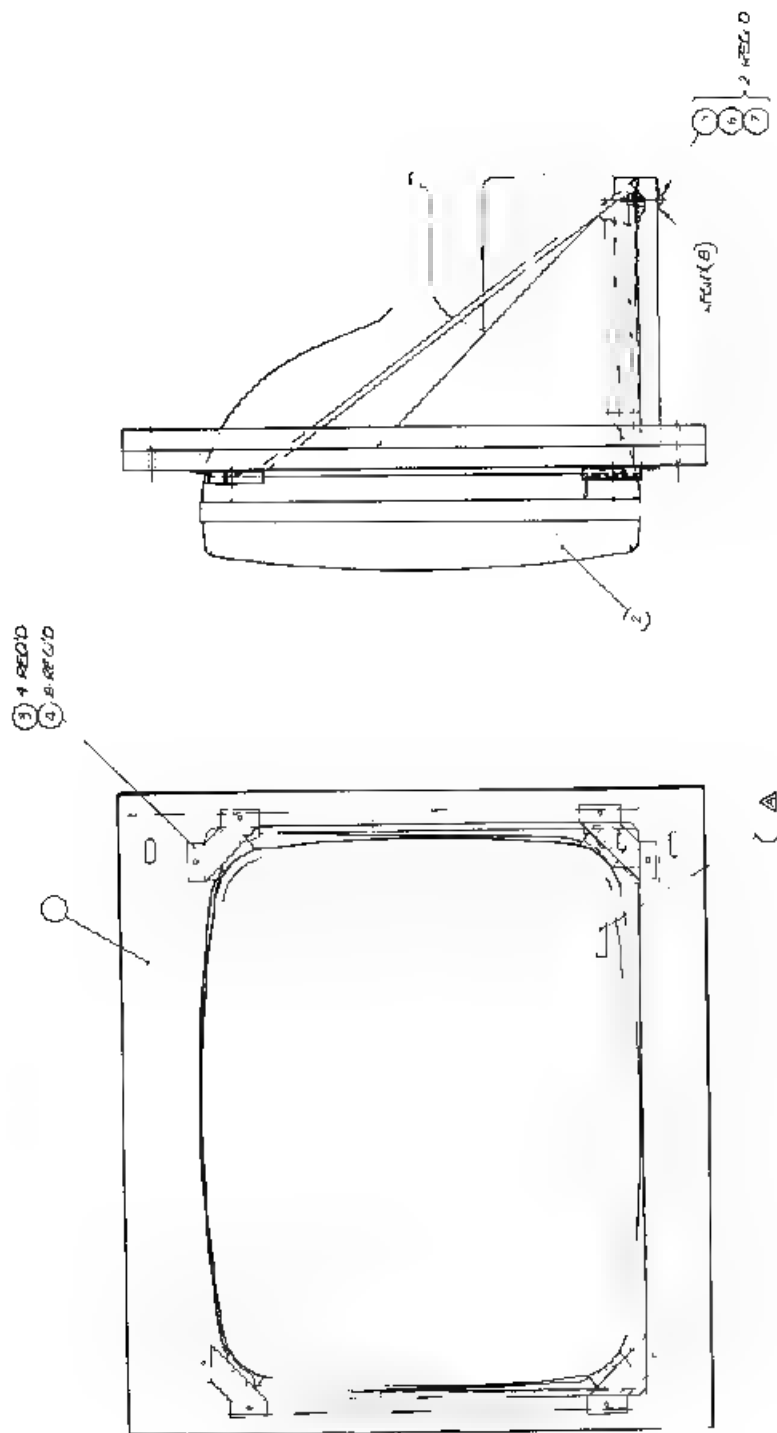



Figure 5-3 TV Monitor Assembly
A032716-01 A



Figure 5-3 TV Monitor Assembly
Parts List

Item	Part Number	Qty.	Description
1	A032746-01	1	Assy T.V. Tray
2	90-032	1	Monitor 23"
3	005594-01	4	Bracket, Monitor Tie Down
4	72-6812	A	Screw, Sm., Pan Hd., Phil. #8 X .75 Lg
5	75-5120	2	Bolt, Carriage #10-24 X 1.25 Lg.
6	75-040C	2	Washer, Split-Lock, #10
7	75-911C	2	Nut, Hex #10-24
8	75-035C	2	Washer, Flat 1/4"
9	006313-02	1	Copyright Decal 1978

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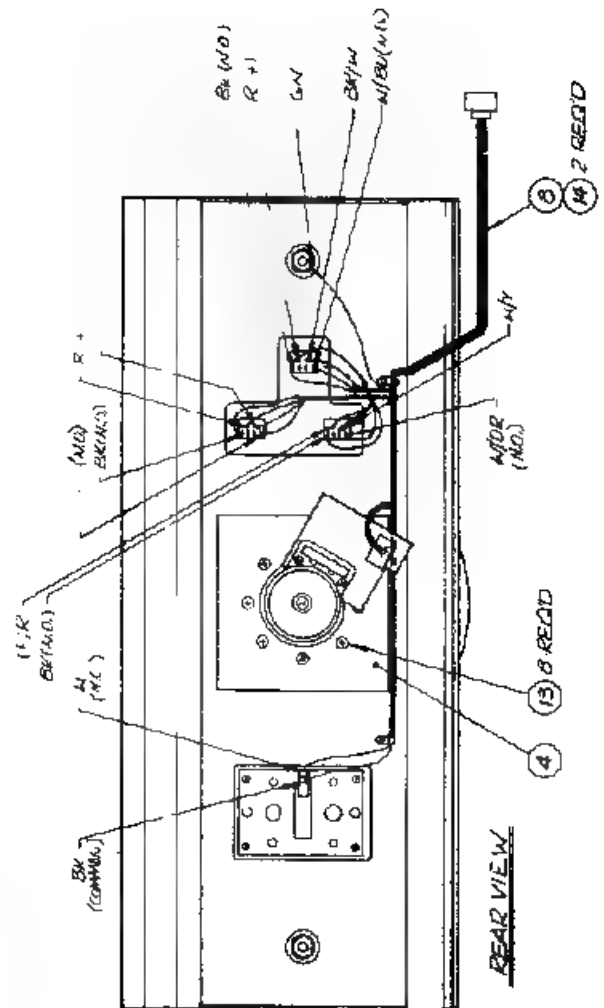
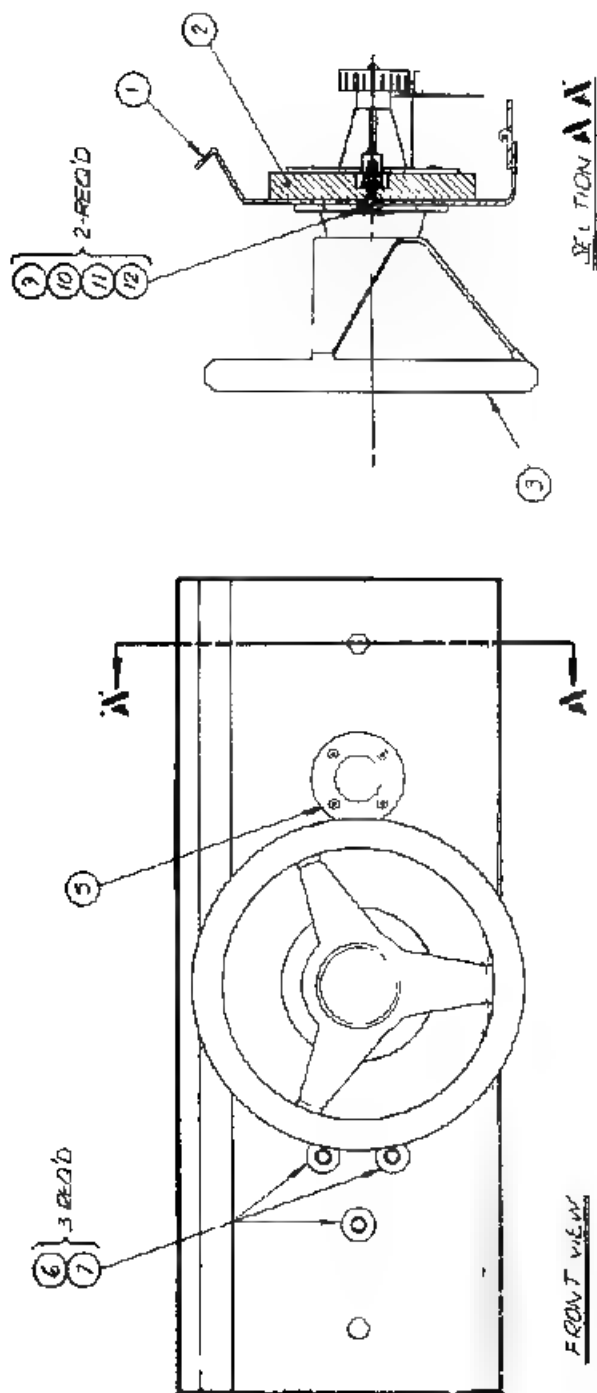


Figure 54 Main Control Panel
A832747-01 A



Figure 5-4 Main Control Panel
Parts List

Item	Part Number	Qty.	Description
1	030959-01	1	Main Cont., Pnc., W/Graphics
2	032699-01	1	Control Panel Wood
3	A000598-03	1	Steering Wheel Ass'y
4	000567 01	1	Bow Washer
5	A007357-01	1	Start Button Ass'y.
6	001856 02	3	Bushing, Alum.
7	62-002	1	Led Switch
8	A032856-01	1	Control Harness
9	75 5520B	2	Carriage Bolt, 1/4-20 X 1.25" Lq Blk
10	75-015S	2	Washer, Flat 1/4
11	75 04520B	2	Washer, Split-Lock 1/4
12	75-915S	2	Nut, Hex, 1/4 20
13	85-22F112	8	Screw, Mach., Pan Hd., Phil. #10-24 X 3/4 Lq., Type F
14	72 6610	2	Screw, Sm., Pan Hd, Phil. #6 X 5/8" Lq.

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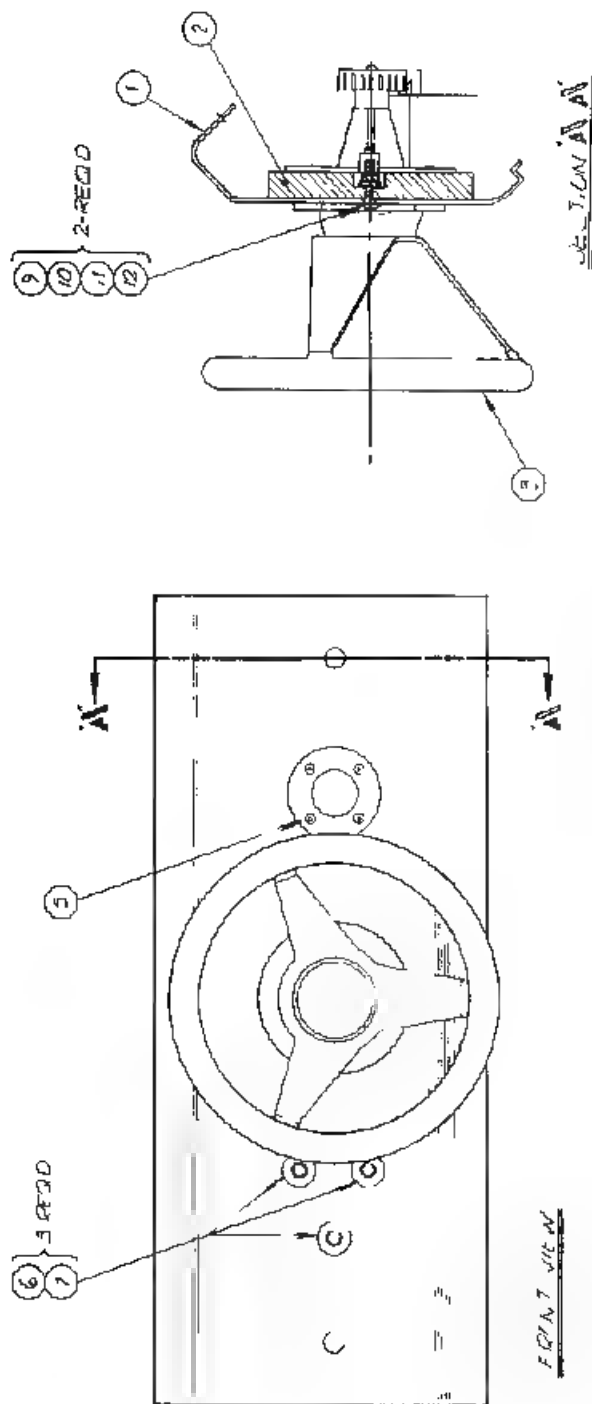


Figure 5-5 Rear Panel Assembly
A032719-01 A

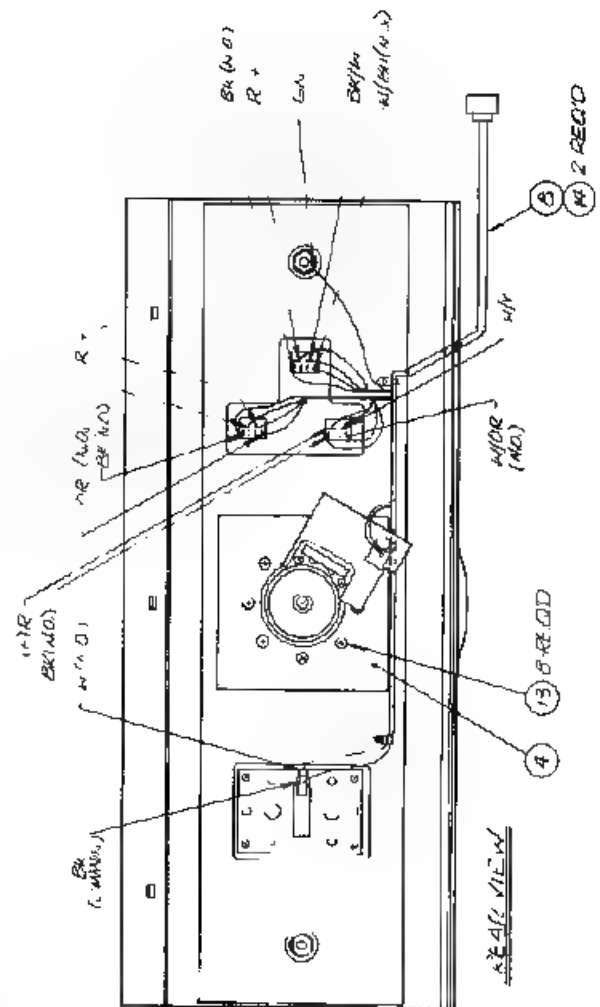




Figure 5-5 Rear Panel Assembly
Parts List

Item	Part Number	Qty.	Description
1	030960-01	1	Rear Cont., Pnc., w/Graphics
2	032699 01	1	Control Panel Wood
3	A000598-03	1	Steering Wheel Ass'y.
4	000567-01	1	Bow Washer
5	A007357-01	1	Start Button Ass'y.
6	001856 02	3	Bushing, Alum.
7	62 002	3	Led Switch
8	A032856-01	1	Control Harness
9	75 5520B	2	Carriage Bolt $\frac{1}{4}$ -20 X 1.25" Lg Blk.
10	75-01SS	2	Washer, Flat $\frac{1}{4}$
11	75-04520B	2	Washer, Split-Lock $\frac{1}{4}$
12	75-915S	2	Nut, Hex, $\frac{1}{4}$ 20
13	85-22F112	8	Screw, Mach, Pan Hd., Phil. #10 24 X 3/4 Lg. Type F
14	72-6610	2	Screw, Sm, Pan Hd, Phil #6 X 5/8" Lg.

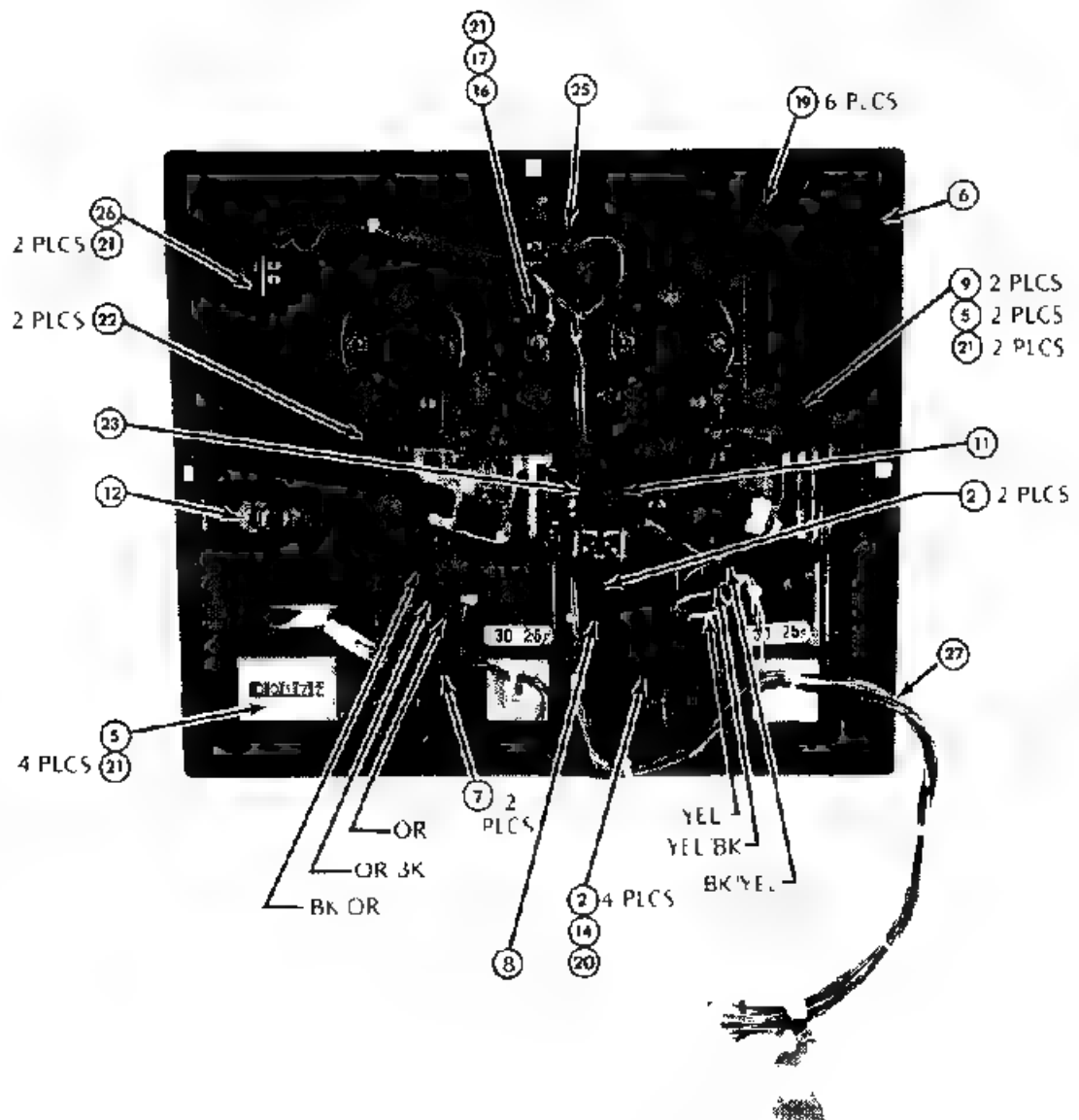


Figure 5-6 Coin Door Assembly
A009083-01 C



Figure 5-6 Coin Door Assembly
Parts List

Item	Part Number	Qty.	Description
1	A00767-01	1	Front Panel Assy. -01 Coin Door Assy.
	A00767-02	Ref.	Front Panel Assy. -02 Coin Door Assy.
	A007637-	Ref.	Front Panel Assy. -03 Coin Door Assy.
	A007637-4	Ref.	Front Panel Assy. -04 Coin Door Assy.
	A007637-0	Ref.	Front Panel Assy. -05 Coin Door Assy.
	A0068-00	Ref.	Front Panel Assy. -06 Coin Door Assy.
	A0063-	Ref.	Front Panel Assy. -07 Coin Door Assy.
2	75-9265	4	Nut
3	A030362-0	1	Coin Door Assy.
4	A007640-01	2	Coin Switch Assembly
5	A002465-0	1	Coin Counter Assembly
6	004320-01	1	Coin Door Gasket
7	004341-0	2	Second Coin
8	004344-01	1	Key
9	04340-	1	Spring
10	004337-0	2	Bracket, with Pin
11	004338-01	1	Lock Pin with Pin
12	004336-0	1	Lock Pin with Pin
13	004326-0	2	Bracket
14	75-046	4	Lock Pin with Pin
15	004904-01	1	Pin
16	007359-0	1	Lock Pin with Pin
17	70-1347	1	Pin
18	75-0008	1	Key Pin with Pin
19	75-99140-1	1	Self-Threading Pin with Pin
20	75-0265	4	Washer
21	75-00516	1	Key Pin with Pin
22	008629-0	1	Pin
23	71-2118	1	Lock Pin with Pin
24	71-2200	1	Lock Pin with Pin
	71-2201	Ref.	Lock Pin with Pin
	71-1201FB	Ref.	Lock Pin with Pin
	71-1201MG	Ref.	Lock Pin with Pin
	71-1201KS	Ref.	Lock Pin with Pin
	71-1210L	Ref.	Lock Pin with Pin
	71-1220A	Ref.	Lock Pin with Pin
25	007753-01	1	Plate with Pin
26	A00763H-1	1	Switch Assembly
27	A006921-01	1	Harmon Assembly

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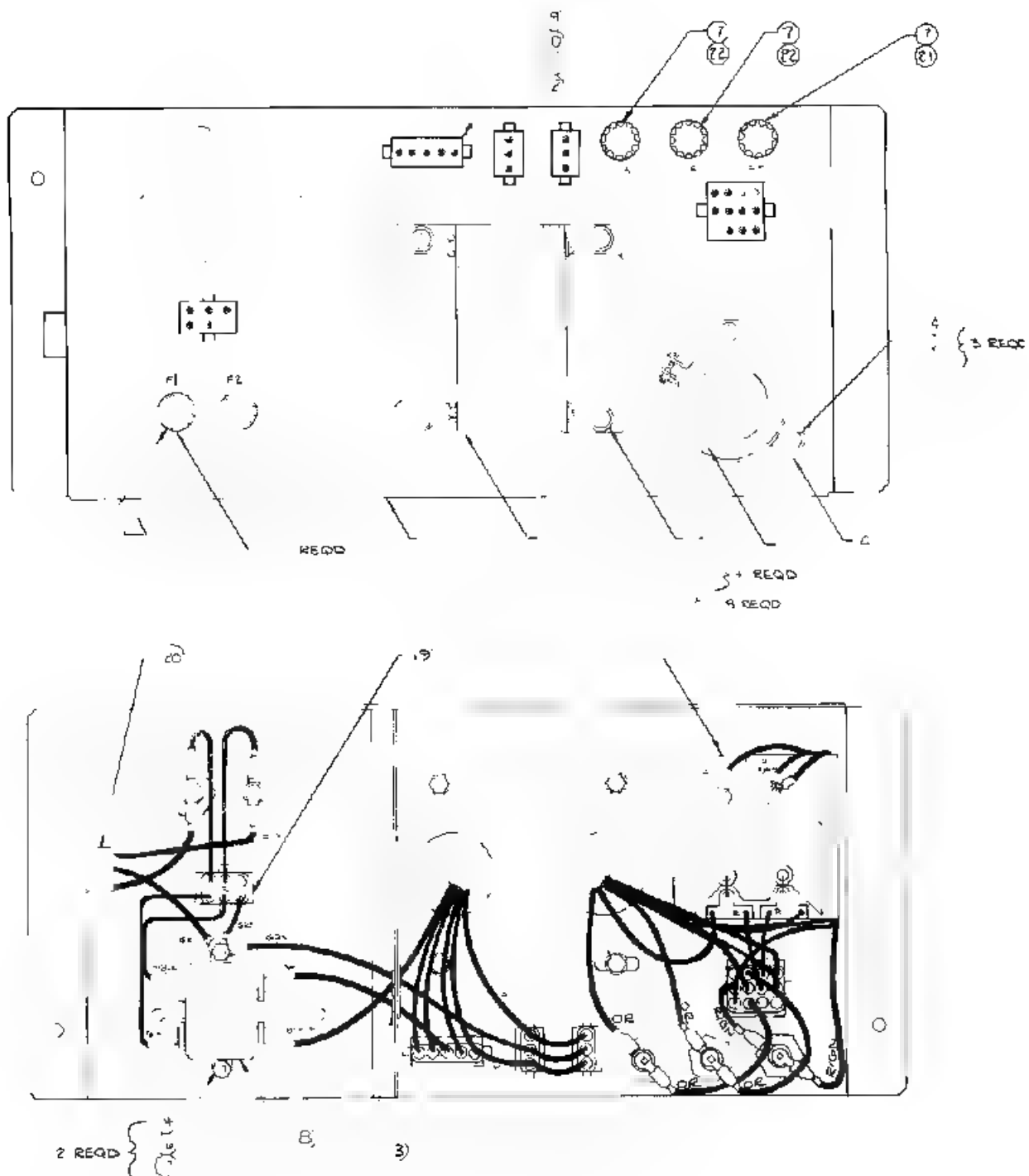


Figure 5-7 Type B Power Supply
A007197-01 C



Figure 5-7 Type B Power Supply
Parts List

Item	Part Number	Qty.	Description
1	A009266-01	1	Power Supply Base Weldment Assembly
2	A006886-01	1	Transformer Termination Assembly "Type B"
3	29-053	1	Cap., Sprague Electrolytic 26,000uf @ 15V
4	78-705015C	1	Brkt., Cap. Mtg. Sprague #4586-48
5	A006555-01	1	P.C. Board Rectifier
6			
7	79 4411004	5	Fuse Holder, Panel Mounting
8	41-2003	1	Filter, Power Line, 5 AMP
9	A006958-01	A/R	Volt Sel Block 95V
10	A006958-02	"	Volt Sel Block 110V
11	A006958 03	"	Volt Sel Block 205V
12	A006958-04	"	Volt Sel Block 220V
13	78-2708	1	Grommet, Plastic
14	72 18106	9	Screw Pan Hd., #8 3/2 x 5/8"lg.
15			
16	75-048	9	Washer, Split-lock #8
17	75-918S	9	Nut Hex #8
18	75-018S	8	Washer Flat #8
19	A007192-01	1	Power Switch Termination
20	A007444-01	1	Power In Harness
21	46-203801	1	Fuse, 8 AMP, 125V, 3 AG Fast Acting
22	46-201251	2	Fuse, 2 1/2 AMP, 125V Slow Acting

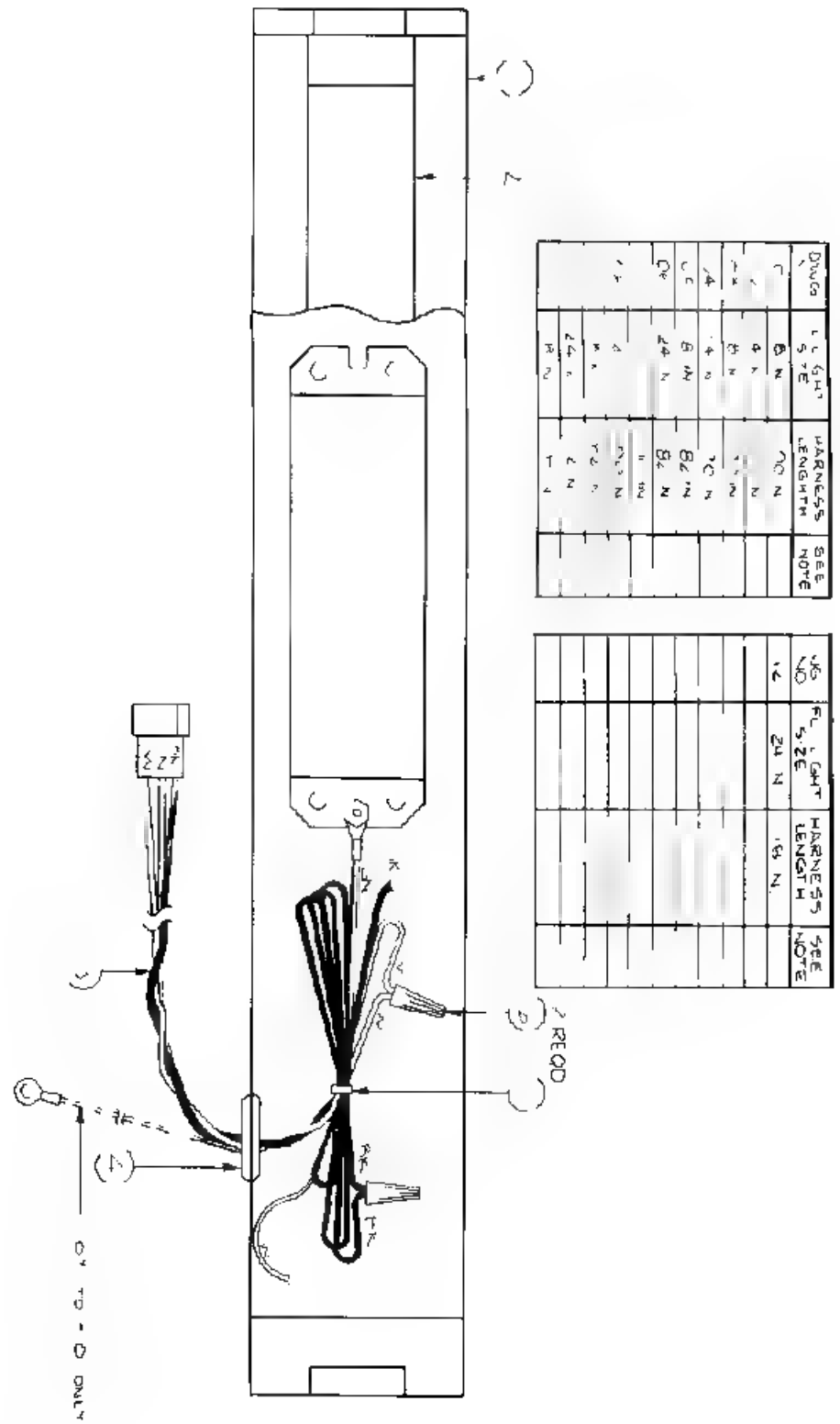
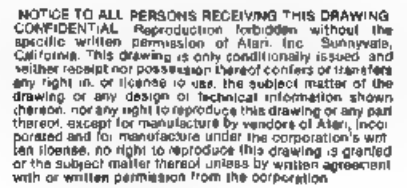


Figure 5-8 Type A Fluorescent Light Assembly
A006917-01 D



Figure 5-8 Type A Fluorescent Light Assembly
Parts List

Item	Part Number	Qty.	Description
1	93-104	1	Gibson Fluorescent Fixture 18 inch
2	70-303	1	Fluorescent Tube 18 inch (or Equivalent)
3	A006916 01	1	Fluorescent Light Harness, 100"
4	78-2652	1	Grommet, Rubber
5	78-24001	A/R	Tie Wrap
6	79-561816	2	Wire Nut, Ideal 71 B




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**Figure 5-9 RF Shield Board Assembly
Parts List**

Item	Part Number	Qty.	Description
1	030835-01	1	P.C. Board
2	2D-1016	24	Cap., Monolithic, 0.1uf, 50 V
3	41 3003	12	Inductor, 100uH
4	52-003	13	Jumper, .600 Centers
5	75-E6106082	9	Wing Screw, #6-32 x 1/2" LG
6	75-952501	9	Fastener, 1/4 Turn, #6-32, Stainless Steel
7	79 517222	1	Connector, 44 Pin P.C. Mount
8	030858-01	2	Mount, Connector

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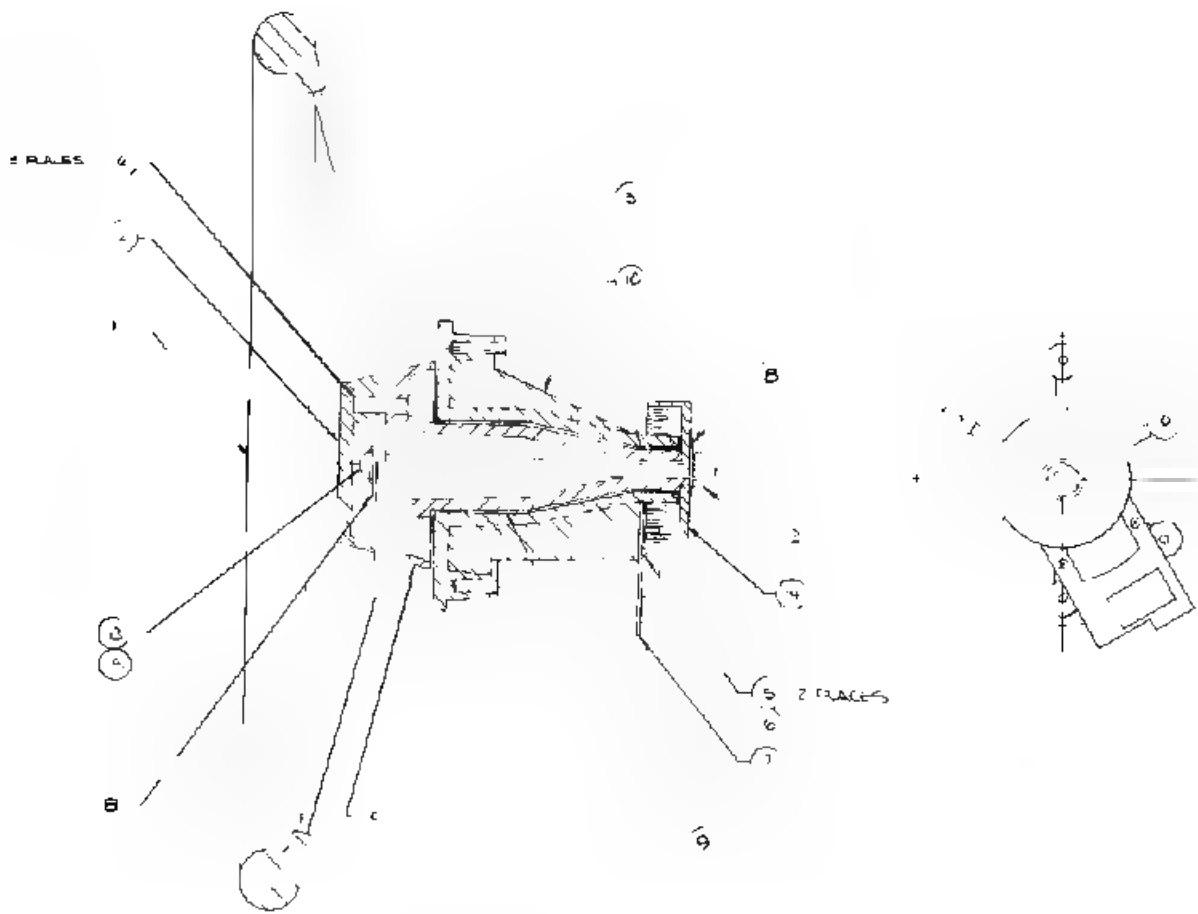


Figure 5-10 Steering Wheel Assembly
A000598-03 R

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Figure 5-10 Steering Wheel Assembly
Parts List

Item	Part Number	Qty	Description
1	A000598-03	Ref	Steering Wheel Assembly
2	000599-02	1	Cover, Atari Logo
3	000605	1	Housing
4	000606	1	Shaft
5	85-22F2 6	2	Scr, Ssr, Metal, #2-56 x 3/8 'F' Type
6	72-7512	3	Mach Scr, #4 20 x 3/4 Lg, Fillister Hd Slotted
7	A000607	1	Printed Circuit Assy
8	75-0700 2	2	Washer, Fender 1/4
9	76-192020	1	Bearing, Thompson 20L20-FX)
10	76-031010	1	Bearing, Thompson 10L10-FX)
11	78-40104	1	Steering Wheel, 10
12	75-990505 S	1	Nut, 1/2-20, Nylon Lock, Shallow Pattern
13	72-9580	1	Mach Scr 1/2 20 x 5 Lg, Truss Hd, Slotted
14	000616	1	Hub Light
15	75-055	1	Washer, 1/2 Int Tooth, Starlock
16	75-042	2	Washer, Split Lock #2

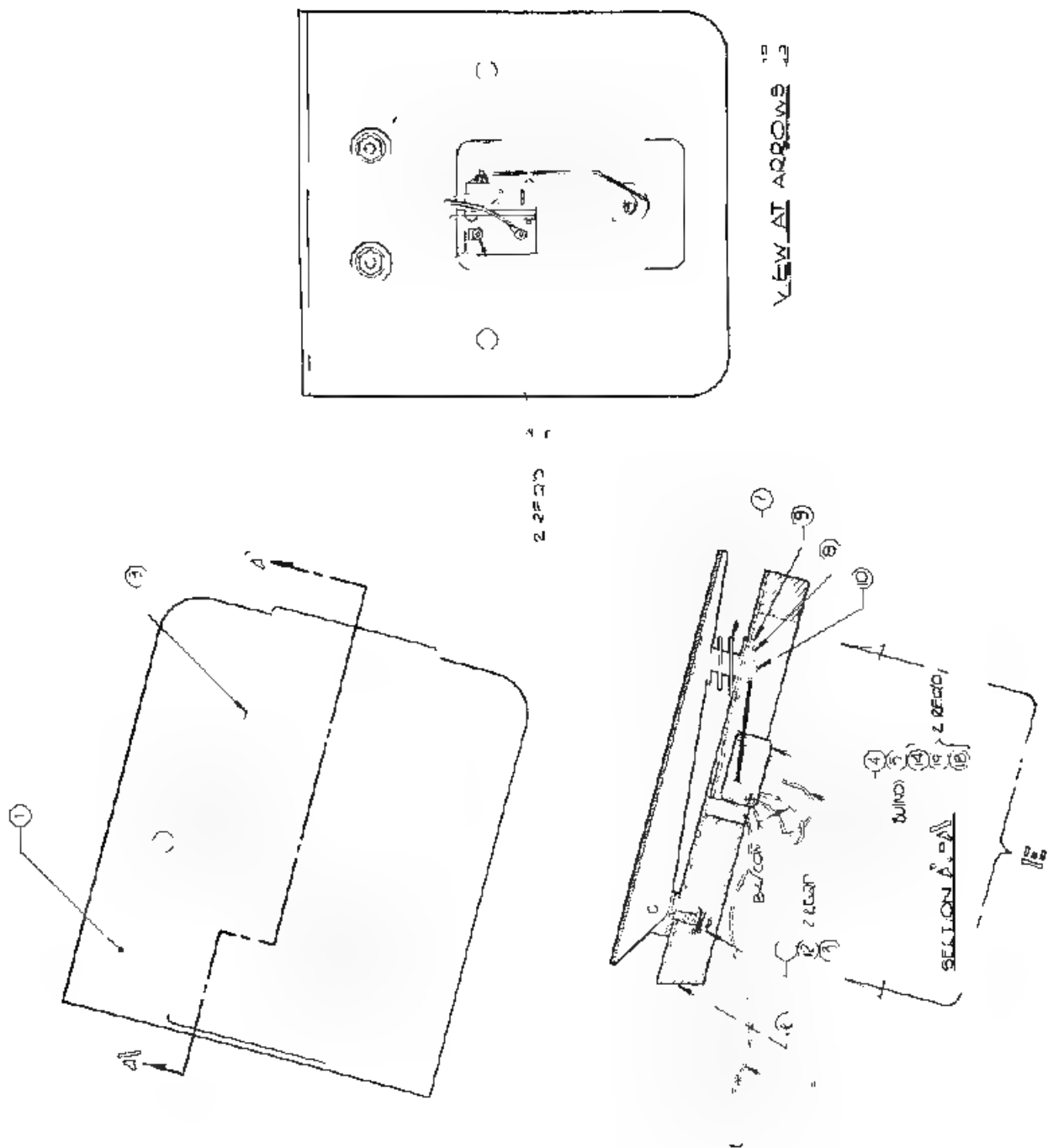


Figure 5-11 Foot Pedal Assembly
A009569-01 C



Figure 5-11 Foot Pedal Assembly
Parts List

Item	Part Number	Qty.	Description
1	009565-01	1	Mounting Plate
2			
3	A008857-01	1	Assy Foot Pedal
4	65-071C	1	Switch Micro
5	002191-01	1	Brkt, Foot Pedal Switch
6	009564-01	1	Mounting Board
7	000592-01	1	Spring
8	75-035C	1	Washer Steel & Wide Pattern)
9	003546-01	1	Washer Rubber & 1D x 1½" OD x 1/8" Thk
10	72-1508C	1	Screw, Mach Pan Hd Phil & 2D x ½ Lg
11	75-915C	2	Nut Hex &"-20
12	75-035C	2	Washer Flat ½"
13	75-045	2	Washer Split-Lock &"
14	72-1412C	2	Screw, Mach, #4 40 x 3/4" Lg.
15	A030003-01	1	Assy Foot Pedal Harness
16	75-9185	2	Nut, Hex, #8-32
17	75-048	2	Washer, Split-Lock, #8
18	75-9148	2	Nut, Hex #4 40
19	75-044	2	Washer, Split-Lock, #4

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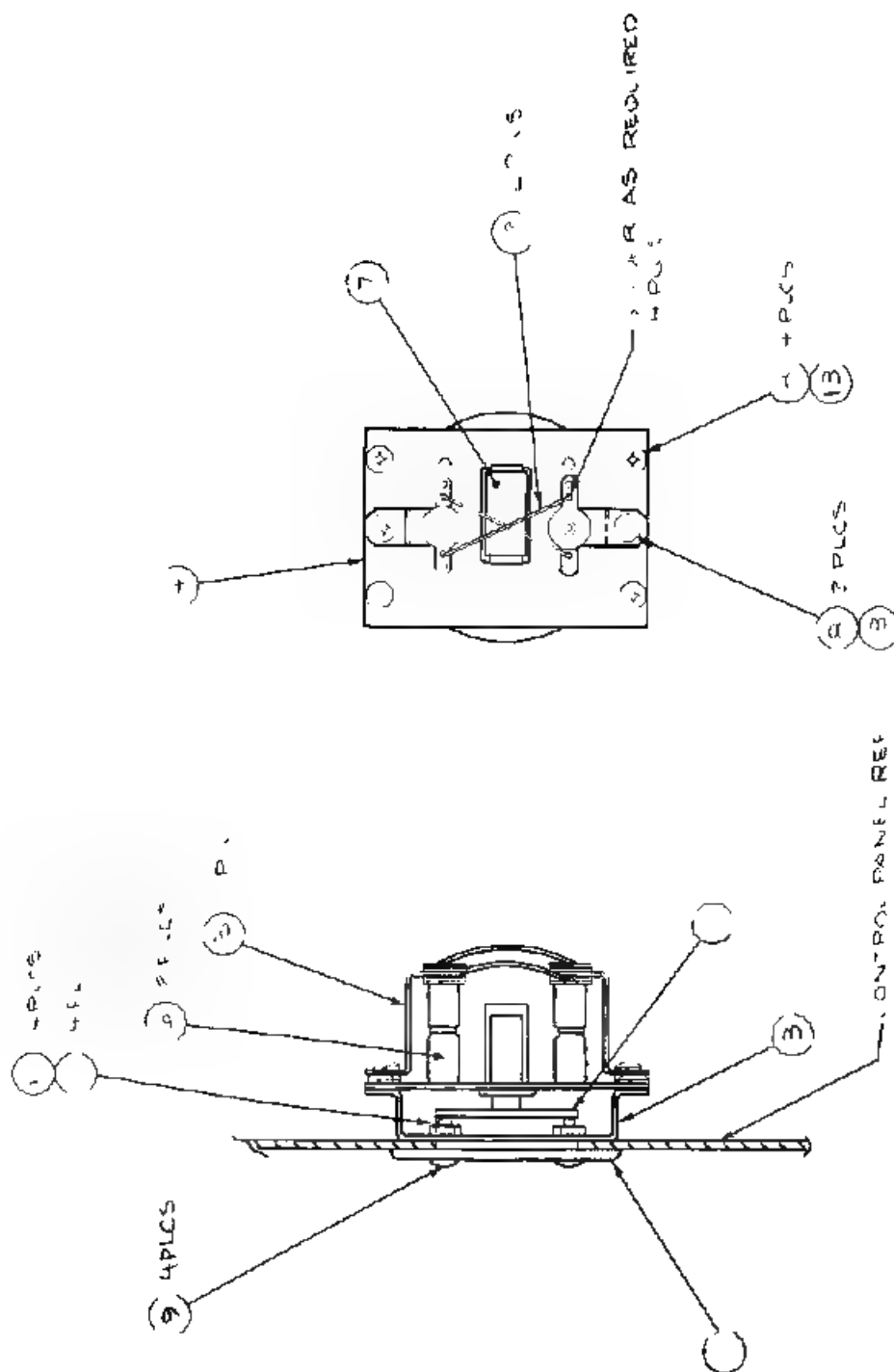


Figure 5-12 Start Button Assembly
A007357-01 D



Figure 5-12 Start Button Assembly
Parts List

Item	Part Number	Qty.	Description
1	006530 01	1	Bezel
2	006535 01	1	Button
3	0065 2-01	1	Chassis
4	A006533 01	1	Switch Mtg. Plate Assembly
5	79-4317	2	Lamp Socket
6	10-11-47	2	Lamp
7	62 020	1	Switch, Cherry, E68 50A
8	72-1603	6	Machine Screw, 6-32 x 3/16 Lg, Pan Hd, Phil
9	82 8808	4	Screw, Button hd socket 8-32 x 1/2 Lg. Black
10	75-9188	4	Nut, 3-32
11	75-048	4	Washer, #8, Split-Lock
12	004577 19	2	Jumper Wire, Black
13	75-046	6	Washer, Split-Lock #6

W A Western Communications Company

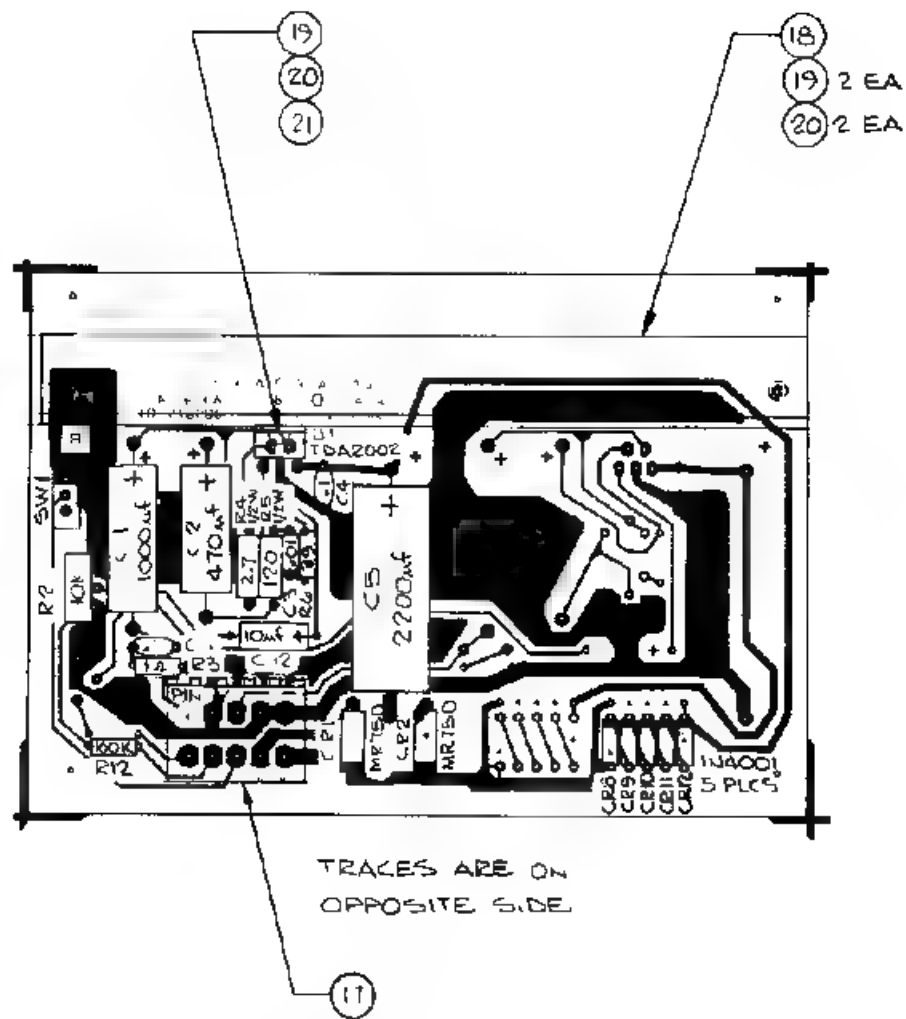


Figure 5-13 Single Audio Amplifier Assembly
A009574-01



Figure 5-13 Single Audio Amplifier Assembly
Parts List

Item	Part Number	Qty.	Description
1	009575-01	1	P.C. Board
2	10-5180	1	Res, Carbon, 5%, 1/4W, 1 OHM R3,10
3	10-5390	1	" " " " 39 " R6,9
4	11-52P7	1	" " " " 1/4W 27 " R4,7
5	11-5121	1	" " " " 120 " R5,8
6	19-316103	1	Trimpot, 10K R1,2
7	24-250106	1	CAP, Electrolytic, 25V, 10uf C12, 13
8	24-250477	1	" " " 470uf C2,7
9	24-250108	1	" " " 1000uf C1,6
10	24-250228	1	" " " 2200uf C5,C10
11	27-250103	1	" Ceramic, 25V .01uf C3,8
12	27-250104	2	" " " .1uf C4,9,11,14
13	31-MR75C	1	Diode MR75C CR1,2
14	31-IN4001	5	Diode IN4001 CR3-12
15	37-TDA2002V	1	Audio AMP, TDA2002V U1,2
16	69-004	1	Switch, Slide SW1
17	78-58005	1	Connector, 10-Position
18	030184-01	1	Heatsink
19	72-1604C	2	Screw, P.H., Phil, #6-32 x 1/2 Lg Cres
20	75-056	2	Washer, Lock, Int Star #6
21	78-16009	1	Silpad
22	10-5104	1	Res, Carbon, 5%, 1/4W, 100K OHM R11,R12

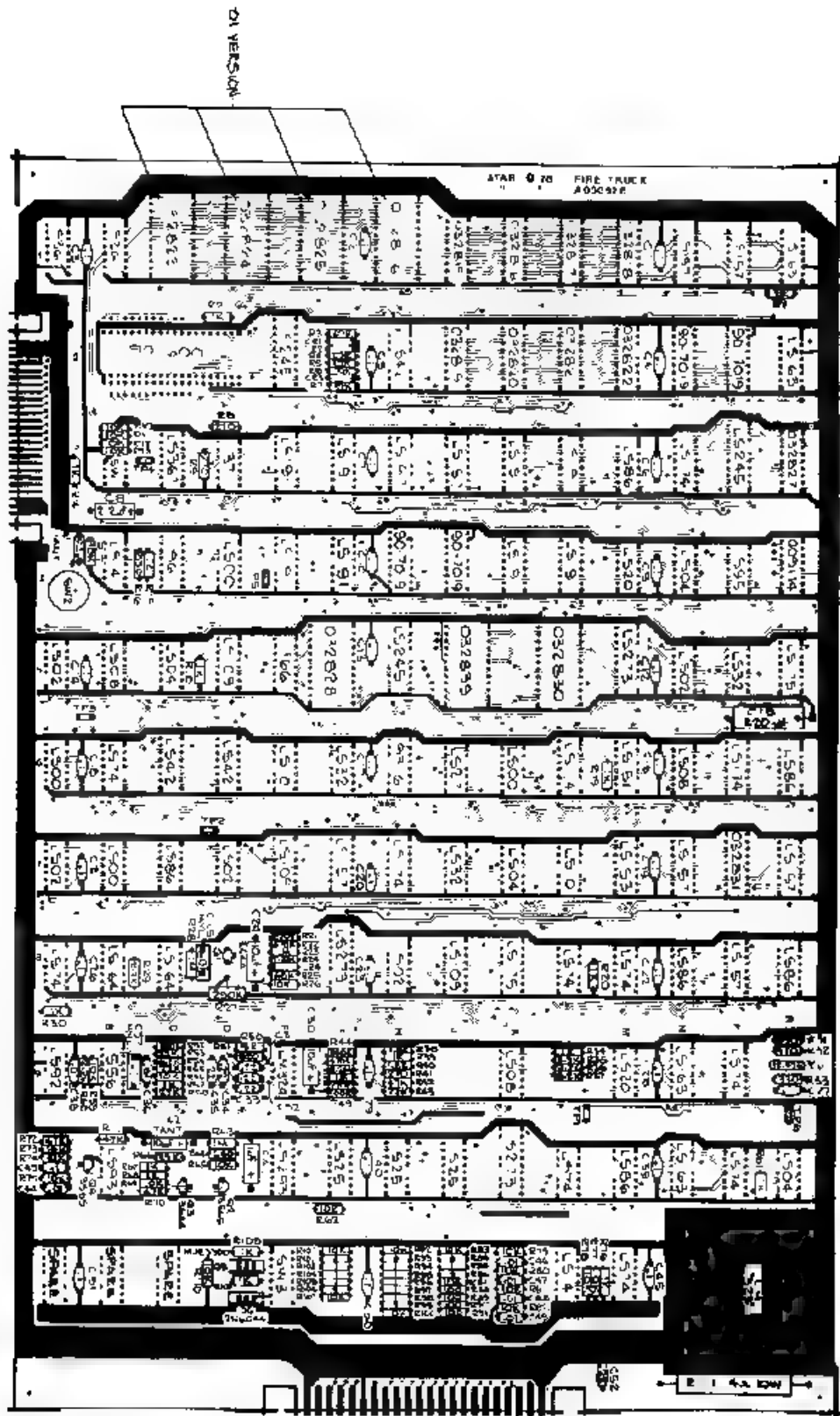


Figure 5-14 Fire Truck P.C.B.
A030926-01 A



Figure 5-14 Fire Truck PCB
Parts List — 01 Version

Item	Part Number	Qty.	Description
1	030927-01	1	P.C. BOARD
2	10-5101	4	RES., CAR. COMP, 5%, $\frac{1}{4}$ W 100 OHM R88-91
3	10-5271	3	" " " " " 270 " R8,9,41
4	10-5331	2	" " " " " 330 " R16,31
5	10-5471	2	" " " " " 470 " R32,33
6	10-5681	1	" " " " " 680 " R64
7	10-5821	1	" " " " " 820 " R51
8	10-5102	17	" " " " " 1K " R1,2,4,15,18-20,30, 34,39,57,61,67,58, 76,108,109
9	10-5182	2	" " " " " 1.8K " R38,40
10	10-5222	3	" " " " " 2.2K " R29,36,60
11	10-5392	1	" " " " " 3.9K " R35
12	10-5472	1	" " " " " 4.7K " R54
13	10-5822	1	" " " " " 8.2K " R17
14	10-5103	47	" " " " " 10K " R3-7,10-13,17,26,56, 59,62,65,69,73-75, 77-87,92-107,110
15	10-5153	1	" " " " " 15K " R50
16	10-5223	2	" " " " " 22K " R43,55
17	10-5273	1	" " " " " 27K " R58
18	10-5333	2	" " " " " 33K " R53,66
19	10-5473	4	" " " " " 47K " R40,70-72
20	10-5683	1	" " " " " 68K " R25
21	10-5104	1	" " " " " 100K " R49
22	10-5154	1	" " " " " 150K " R52
23	10-5224	2	" " " " " 220K " R21,48
24	10-5394	1	" " " " " 390K " R44
25	10-5474	2	" " " " " 470K " R22,45
26	10-5105	4	" " " " " 1M " R23,28,47,63
27	10-5225	2	RES., CAR. COMP, 5%, $\frac{1}{4}$ W 2.2M " R24,42
28			
29			
30	19-315254	1	TRIMPOT, 250K OHM R27
31	19-808W4P0	1	RES., WIREWOUND, 10W, 4 OHM R111
32			
33	21-101103	1	CAP., MYLAR, 100V .01uf C25
34	21-101104	1	CAP., MYLAR, 100V 0.1uf C37
35			



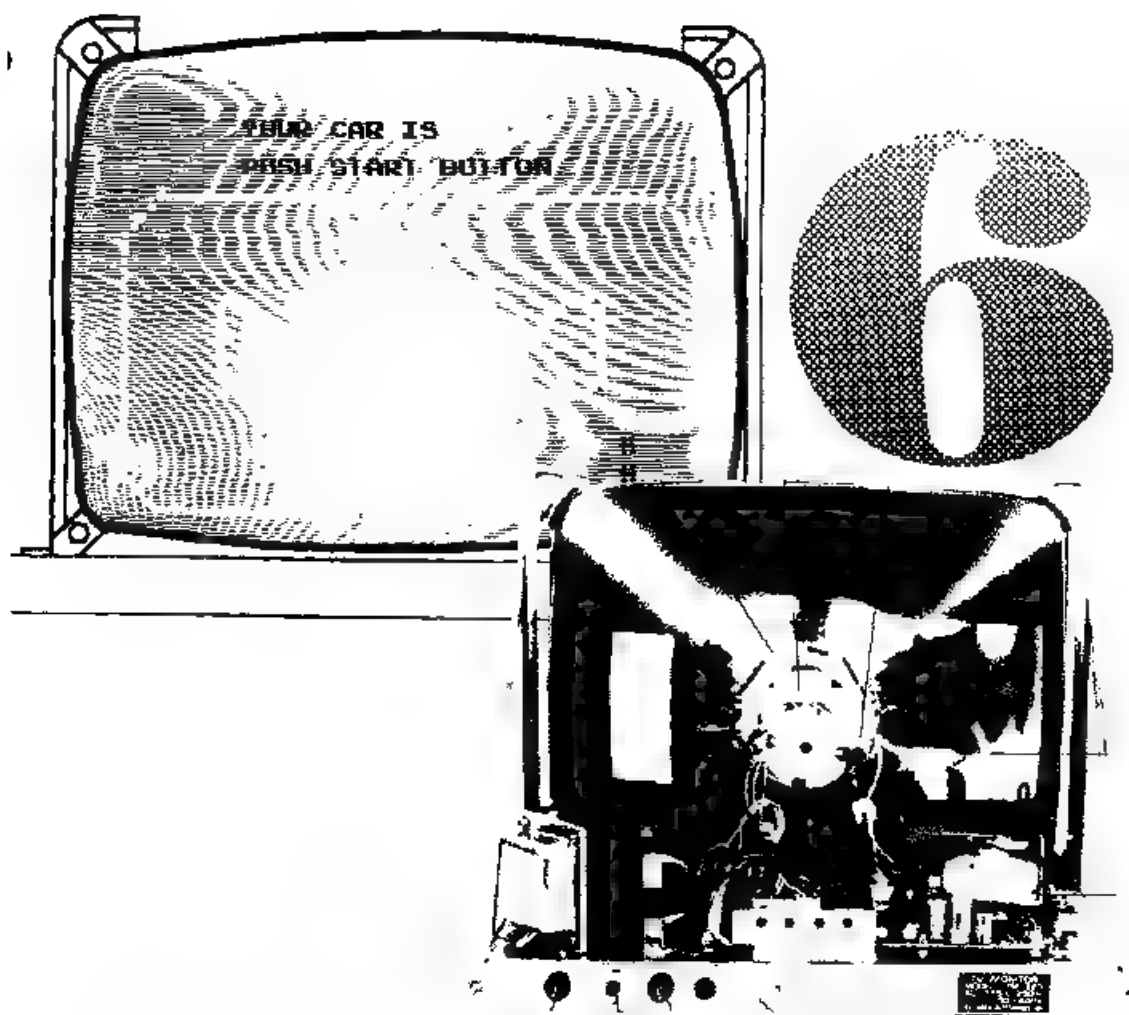
Figure 5-14 Fire Truck PCB
Parts List —02 Version

Item	Part Number	Qty.	Description
1	030927-01	1	P.C. BOARD
2	10-5101	4	RES., CAR. COMP, 5%, $\frac{1}{4}$ W 100 OHM R88-91
3	10-5271	3	" " " " " 270 " R8,9,41
4	10-5331	2	" " " " " 330 " R16,31
5	10-5471	2	" " " " " 470 " R32,33
6	10-5681	1	" " " " " 680 " R64
7	10-5821	1	" " " " " 820 " R51
8	10-5102	17	" " " " " 1K " R1,2,4,15,19-20,30, 34,39,57,61,67,68, 76,108,109
9	10-5182	2	" " " " " 1.8K " R38,40
10	10-5222	3	" " " " " 2.2K " R29,36,60
11	10-5392	1	" " " " " 3.9K " R35
12	10-5472	1	" " " " " 4.7K " R54
13	10-5822	1	" " " " " 8.2K " R37
14	10-5103	47	" " " " " 10K " R3-7,10-13,17,26,56, 59,62,65,69,73-75, 77-87,92-107,110
15	10-5153	1	" " " " " 15K " R50
16	10-5223	2	" " " " " 22K " R43,55
17	10-5273	1	" " " " " 27K " R58
18	10-5333	2	" " " " " 33K " R53,66
19	10-5473	4	" " " " " 47K " R40,70-72
20	10-5683	1	" " " " " 68K " R25
21	10-5104	1	" " " " " 100K " R49
22	10-5154	1	" " " " " 150K " R52
23	10-5224	2	" " " " " 220K " R21,48
24	10-5394	1	" " " " " 390K " R44
25	10-5474	2	" " " " " 470K " R22,45
26	10-5105	4	" " " " " 1M " R23,28,47,63
27	10-5225	2	RES., CAR. COMP, 5%, $\frac{1}{4}$ W 2.2M " R24,42
28			
29			
30	19-315254	1	TRIMPOT, 250K OHM R27
31	19-808W4PO	1	RES., WIREWOUND, 10W, 4 OHM R111
32			
33	21-101103	1	CAP., MYLAR, 100V .01uf C25
34	21-101104	1	CAP., MYLAR, 100V 0.1uf C37
35			



Figure 5-14 Fire Truck PCB
Parts List - 02 Version

Item	Part Number	Qty.	Description
36	26-250105	1	CAP., ELECTROLYTIC 2V 10F
37	26-250226	1	" " 2V 10F
38	26-250106	1	CAP., ELECTROLYTIC 2V 10F
39	26-250227	1	" " 2V 10F
40	12-250103	1	CAP., CER. DISC. 25V .01uF
41	12-250104	1	CAP., CER. DISC. 25V .01uF
42	2-250224	30	CAP., CER. DISC. 25V .01uF
43	29-010	6	CAP., TANTALUM 20V .01uF
44	29-006	1	CAP., TANTALUM 20V .01uF
45	31-0916	4	DIODE, 100V 1W
46	31-0916	4	DIODE, 100V 1W
47	31-0916	4	DIODE, 100V 1W
48	31-0916	4	DIODE, 100V 1W
49	31-0916	4	DIODE, 100V 1W
50	31-0916	4	DIODE, 100V 1W
51	31-0916	4	DIODE, 100V 1W
52	31-0916	4	DIODE, 100V 1W
53	31-0916	4	DIODE, 100V 1W
54	31-0916	4	DIODE, 100V 1W
55	31-0916	4	DIODE, 100V 1W
56	31-0916	4	DIODE, 100V 1W
57	31-0916	4	DIODE, 100V 1W
58	31-0916	4	DIODE, 100V 1W
59	31-0916	4	DIODE, 100V 1W
60	31-0916	4	DIODE, 100V 1W
61	31-0916	4	DIODE, 100V 1W
62	31-0916	4	DIODE, 100V 1W
63	31-0916	4	DIODE, 100V 1W
64	31-0916	4	DIODE, 100V 1W
65	31-0916	4	DIODE, 100V 1W
66	31-0916	4	DIODE, 100V 1W
67	31-0916	4	DIODE, 100V 1W
68	31-0916	4	DIODE, 100V 1W
69	31-0916	4	DIODE, 100V 1W
70	31-0916	4	DIODE, 100V 1W
71	31-0916	4	DIODE, 100V 1W
72	31-0916	4	DIODE, 100V 1W
73	31-0916	4	DIODE, 100V 1W
74	31-0916	4	DIODE, 100V 1W
75	31-0916	4	DIODE, 100V 1W
76	31-0916	4	DIODE, 100V 1W
77	31-0916	4	DIODE, 100V 1W
78	31-0916	4	DIODE, 100V 1W
79	31-0916	4	DIODE, 100V 1W
80	31-0916	4	DIODE, 100V 1W
81	31-0916	4	DIODE, 100V 1W
82	31-0916	4	DIODE, 100V 1W
83	31-0916	4	DIODE, 100V 1W
84	31-0916	4	DIODE, 100V 1W



TV MONITOR SERVICING INFORMATION

This chapter provides servicing information taken from the Motorola and TEC service manuals. Each manual has been reprinted by permission of the respective monitor manufacturer.

Your game will include either the Motorola or TEC monitor, depending on the availability during production.



MOTOROLA

Service Manual

CAUTION

No work should be attempted on any exposed monitor chassis by anyone not familiar with servicing procedures and precautions.

A. GENERAL INFORMATION

This manual contains information on the M5000/M7000 monitor series and the +5 volt logic power supply. The M5000 uses a 19-inch CRT and the M7000 uses a 23-inch CRT. All CRTs are of the magnetic deflection type with integral implosion protection.

All monitor power supplies are capable of producing both +75 and +12 volts regulated from either 115-volt or 230-volt AC input to the transformer primary. All monitor variations described herein require a composite video input signal.

Note

This service manual refers to the Sky Raider Monitor only.

Input and output connections for the monitors are made through a 12-pin connector plug located at the rear of the chassis. Inputs consist of composite video, audio, and 115/220 volt AC three-wire.

All monitors employ four stages of video amplification, a two-stage sync separator, a two-stage vertical integrator, a four-stage horizontal sweep circuit, a three-stage vertical sweep circuit, a one-stage spot kill, a one-stage blanking amplifier, and a regulated full-wave bridge power supply.

Model Breakdown Chart

Model	Video Input	19" CRT	23" CRT
M5000-155	Composite	X	
M7000-155	Composite		X

SAFETY WARNING

CAUTION

No work should be attempted on an exposed monitor chassis by anyone not familiar with servicing procedures and precautions.

1. Safety procedures should be developed by habit so that technicians rushed with repair work automatically take precautions.
2. A good practice when working on any unit is to first ground the chassis and to use only one hand when testing circuitry. This will avoid the possibility of carelessly putting one hand on chassis or ground and the other on an electrical connection which could cause a severe electrical shock.
3. Extreme care should be used in handling the picture tube as rough handling may cause it to implode due to atmospheric pressure (14.7 lbs. per sq. in.). Do not nick or scratch glass or subject it to any undue pressure in removal or installation.

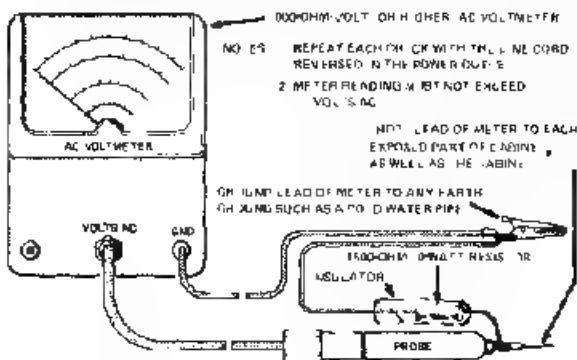
When handling, safety goggles and heavy gloves should be worn for protection. Discharge picture tube by shorting the anode connection to chassis ground (not cabinet or other mounting parts). When discharging, go from ground to anode or use a well-insulated piece of wire. When servicing or repairing the monitor, if the cathode ray tube is replaced by a type of tube other than that specified under the Motorola Part Number as original equipment in this Service Manual, then avoid prolonged exposure at close range to unshielded areas of the cathode ray tube. Possible danger of personal injury from unnecessary exposure to X-ray radiation may result.

4. An isolation transformer should always be used during the servicing of a unit whose chassis is connected to one side of the power line. Use a transformer of adequate power rating as this protects the serviceman from accidents resulting in personal injury from electrical shocks. It will also protect the chassis and its components from being



damaged by accidental shorts of the circuitry that may be inadvertently introduced during the service operation.

5. Always replace protective devices, such as fishpaper, isolation resistors and capacitors and shields after working on the unit.
6. Before returning a serviced unit, the service technician must thoroughly test the unit to be certain that it is completely safe to operate without danger of electrical shock. Do not use a line isolation transformer when making this test.



Voltmeter Hook-up for Safety Check

In addition to practicing the basic and fundamental electrical safety rules, the following test, which is related to the minimum safety requirements of the Underwriters Laboratories, should be performed by the service technician before any unit which has been serviced is installed in a game again.

A 1000-ohm-per-volt AC voltmeter is prepared by shunting it with a 1500-ohm 10-watt resistor. The safety test is made by contacting one meter probe to any portion of the unit exposed to the operator such as the cabinet trim hardware, controls, knobs, etc., while the other probe is held in contact with a good earth ground such as a cold water pipe.

The AC voltage indicated by the meter must not exceed 7½ volts. A reading exceeding 7½ volts indicates that a potentially dangerous leakage path exists between the exposed portion of the unit and earth ground. Such a unit represents a potentially serious shock hazard to the operator.

The above test should be repeated with the power plug reversed, when applicable.

Never reinstall a monitor which does not pass the safety test until the fault has been located and corrected.

Table 6-1 Motorola Monitor Electrical Specifications

	MODEL M5000-155	MODEL M7000-155
PICTURE TUBE	19" measured diagonally (48.2 cm), 184 sq. inch viewing area (1188 sq. cm), 114° deflection angle, integral implosion protection, P4 phosphor standard.	23" measured diagonally (58.4 cm), 282 sq. inch viewing area (1820 sq. cm), 110° deflection angle, integral implosion protection, P4 phosphor standard.
POWER INPUT	115/230 VAC, 110 Watts (nominal), 60 Hz provision for 230 VAC, 50 Hz.	
FUSES	M5000-155, M7000-155 — 0.8A	
+73 VOLT SUPPLY	Electronically regulated over AC inputs from 103 VAC to 130 VAC, or 260 VAC to 260 VAC.	
VIDEO INPUT	0.5 Volts to 2.5 Volts P-P maximum, composite for 50% at CRT.	
RESOLUTION	500 lines at picture center.	
LINEARITY	Within 3% measured with standard EIA ball chart and dot pattern.	

Table 6-1 Motorola Monitor Electrical Specifications

HIGH VOLTAGE	17kV (nominal)
HORIZONTAL BLANKING INTERVAL	11 microseconds typical (includes retrace and delay)
SCANNING FREQUENCY	Horizontal: 15,750 Hz \pm 500 Hz; Vertical: 50/60 Hz
ENVIRONMENT	Operating temperature: 10°C to 35°C (ambient) Storage Temperature: -40°C to +65°C Operating Altitude: 10,000 ft. maximum (3048 meters) Designed to comply with applicable DHEW rules on X Radiation CSA certified for use in coin-operated amusements in a combustible enclosure UL listed under specification 1410 (electronic components)
TYPICAL DIMENSIONS	14.11" H, 18.18" W, 14.83" D (35.8 x 46 x 37.6 cm) 16.72" H, 21.56" W, 16.18" D (42.4 x 54.7 x 41 cm)

Specifications subject to change without notice

B. SERVICE NOTES

Circuit Tracing

Component reference numbers are printed on the top and bottom of the three circuit cards to facilitate circuit tracing. In addition, component names are also shown and referenced on the schematic diagram in this manual.

Transistor elements are identified as follows:
E—Emitter B—Base C—Collector

Component Removal

Removing components from an etched circuit card is facilitated by the fact that the circuitry (copper foil) appears on one side of the circuit card only and the component leads are inserted straight through the holes and are not bent or crimped.

It is recommended that a solder extracting gun be used to aid in component removal. An iron with a temperature-controlled heating element would be desirable since it would reduce the possibility of damaging the circuit card foil due to overheating.

The nozzle of the solder extracting gun is inserted directly over the component lead and when sufficiently heated, the solder is drawn away, leaving the lead free from the copper foil. This method is particularly suitable in removing multi-terminal components.

CRT Replacement

Use extreme care in handling the CRT, as rough handling may cause it to implode due to high vacuum pressure. Do not nick or scratch glass or subject it to any undue pressure in removal or installation. Use goggles and heavy gloves for protection. In addition, be sure to disconnect the monitor from all external voltage sources.

1. Discharge CRT by shorting 2nd anode to ground, then remove the CRT socket, deflection yoke and 2nd anode lead.
2. Remove CRT from the front of the chassis by loosening and removing four screws, one in each corner of the CRT.

Adjustments

A non-metallic tool is recommended when performing the following adjustments:

Regulator Adjustment

NOTE

Maladjustment of the +73 volt regulator or the horizontal oscillator may result in damage to the horizontal output transistor or pulse-former diode. The following procedure is recommended to insure reliable operation:

1. Connect the monitor to an AC line supply, then adjust supply to 120 volts (240 volts in some applications)
2. Apply test signal to proper input. Signal should be of same amplitude and sync rate as when monitor is in service
3. Adjust HOR. SET control until display is stable
4. Connect a DC digital voltmeter (or equivalent precision voltmeter) to the emitter of the regulator output transistor, Q17 (or any +73 volt test point)
5. Adjust the 73V ADJUST control R93, for an output of +73 volts. Do not rotate the control through its entire range. Damage to the monitor may result
6. When adjustment is complete, the AC line supply can be varied between 103 and 131 volts AC to check for proper regulator operation. With the regulator operating properly, changes in display size should be negligible

Horizontal Hold/Oscillator Adjustment

Adjust the core of HOR. SET control until the horizontal blanking lines are vertical or the CRT display is stable (synced)

Vertical Height-Linearity Adjustment

1. Connect a test generator whose output is similar to the display signal normally used

2. Rotate the vertical size control R60 until the smallest display is obtained
3. Adjust the vertical linearity control R64 until the top and bottom of the test pattern is equally spaced
4. Readjust R60 until the desired display height is obtained
5. Readjust R64, if necessary, as in Step 2 above

Focus Adjustment

The best overall focus of the display is obtained by adjusting the focus control R42, for best focus at a point which is near the center and approximately 1/3 down from the top of the display

Monitor Servicing

The monitor circuit board may be installed in a service position to provide easier access to the circuit foil when servicing the monitor (see Figure 6-1)

C. THEORY OF OPERATION

Power Supply

The power supplies are transformer operated full wave regulated supplies which maintain constant output voltages for input line variations of 103 volts AC to 130 volts AC or 206 volts AC to 260 volts AC. Regulation of the output voltages is accomplished by using positive feedback through the integrated circuit reference amplifier

+73 Volt Supply (See Figures 6-3, 6-4)

When the +73 volt supply attempts to increase, the voltage at pin 3 of IC1 will increase, while the voltage at pin 2 remains constant due to D20. The increasing voltage at pin 3 will cause the output voltage of the reference amplifier (pin 6), to increase the forward bias of Q19. The collector voltage of Q19, forward bias of Q18, and the base current of Q17 will all decrease. The resultant proportional increase of Q17 collector to-emitter voltage will cancel the attempted output voltage increase

When the +73 volt supply bus attempts to decrease, the voltage at pin 3 of IC1 will decrease while the voltage at pin 2 remains constant. The decreasing voltage at pin 3 will cause the reference amplifier output voltage at pin 6 to decrease the forward bias of Q19. The collector voltage of Q19, the forward bias of Q18 and the base current of Q17 will increase. The collector to-emitter voltage of Q17, which is in series

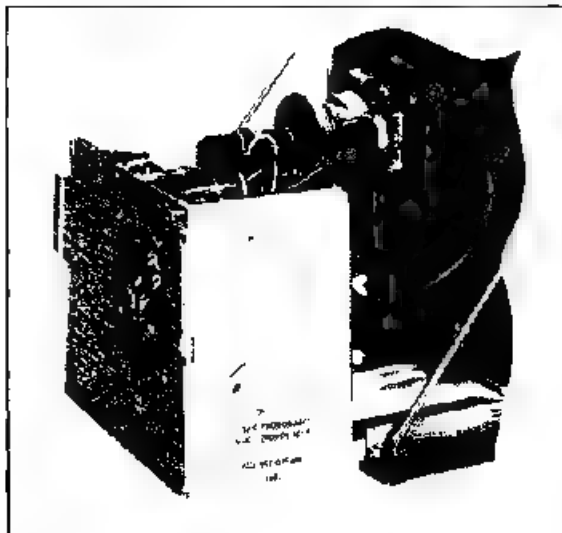


Figure 6-1 Motorola Monitor Circuit Board in Service Position

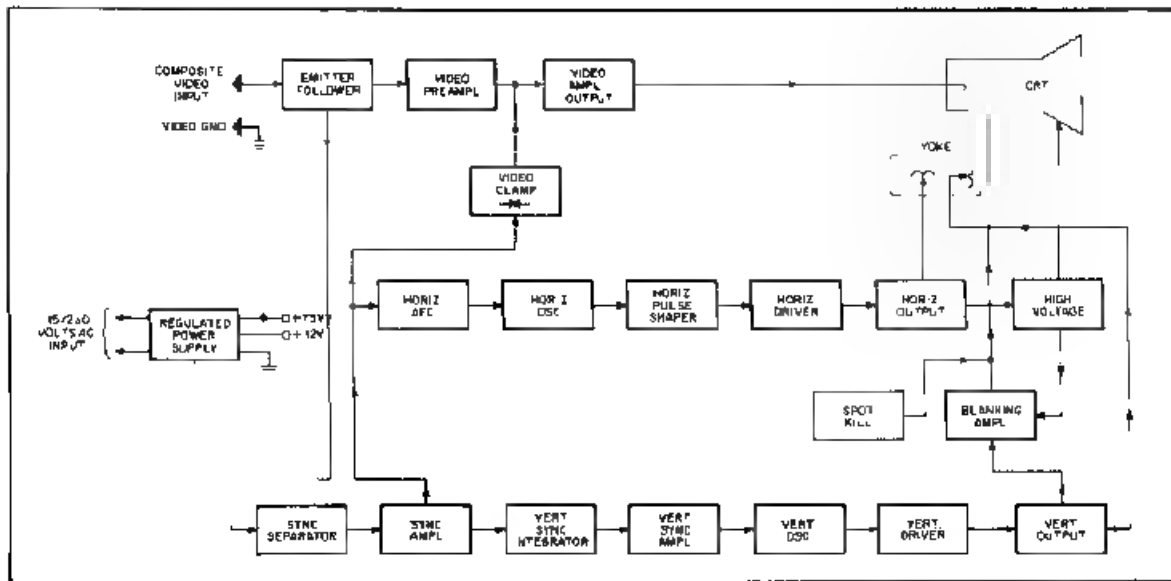


Figure 6-2 Motorola Monitor Block Diagram

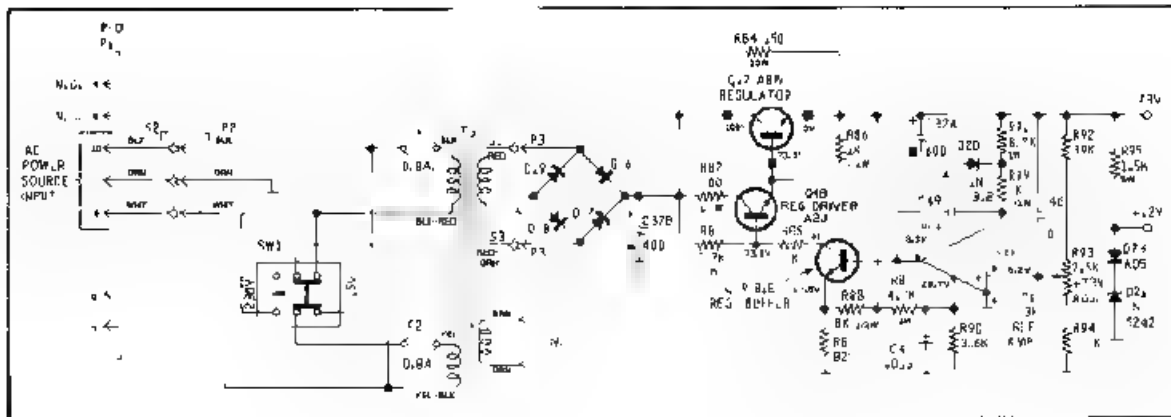


Figure 6-3 +73 Volt Supply Circuit

with the output will decrease proportionally to the attempted decrease in the output bus.

Resistor R84 shunts a portion of the output current around Q17 so less power is dissipated within the device. Resistor R82 is the current limiting resistor for Q18, and R86 controls the leakage current of Q17. Resistors R83 and R85 are the collector load for Q19, and R88 and R87 provide an emitter voltage for Q19 within the range of IC1's output voltage variations. Capacitor C45 filters high frequency variations from the voltage at pin 7 of IC1, and C49 is a Miller-effect capacitor which eliminates instability

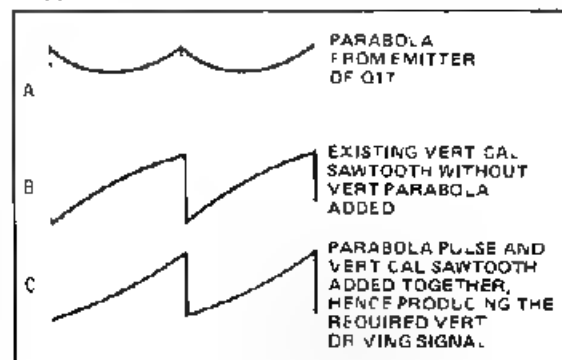


Figure 6-4 Motorola Monitor Vertical Drive Waveform

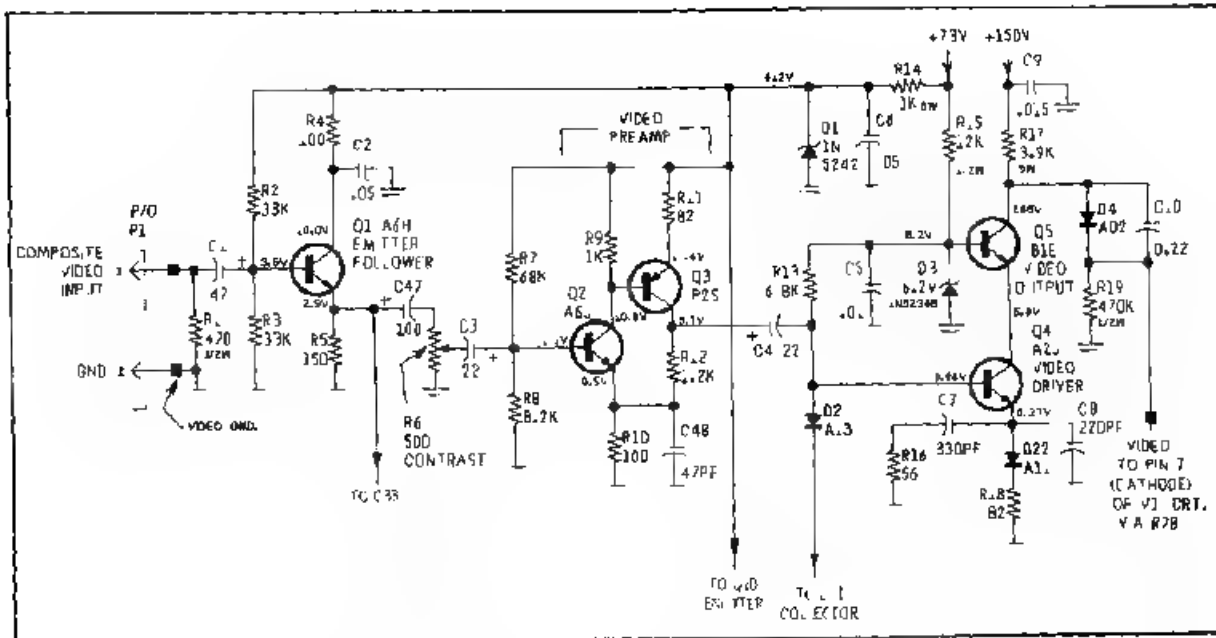


Figure 6-5 Motorola Monitor Video Amplifiers and Output Circuit

Capacitor C32A filters horizontal frequency variations from the output bus.

Resistor R91 provides bias current for D20, and the value of R99 presents an impedance from pin 2 of C1 to AC ground (through D20). Capacitor C46 couples high frequency voltage variations, which occur at the output bus—back to pin 3—preventing oscillations for proper operation of the reference amplifier. Resistors R92, R93, and R94 provide voltage division such that the adjustment of R93 can be set equal to the voltage of pin 2 of C1. Resistor R95 provides bias current for D21 and also provides the +12 volt output. Diode D23 is necessary to temperature-compensate for variations within D21. Capacitor C32B filters AC variations from the output of the full wave bridge.

Video Amplifiers and Output (See Figure 6-5)

The composite video signal is coupled to the emitter-to-lower Q1 through the input connector P1 and capacitor C1. Transistor Q1 is a buffer stage which matches the impedance of the signal source to the video preamplifier and the sync separator stages. Resistor R1 is a terminating resistor for the video signal source, and resistors R2, R3, R4, and R5 form the biasing network for the stage. Capacitor C2 bypasses higher video frequencies to ground. The

composite video signal is coupled from the emitter of Q1 to the sync separator Q10 through C33 and to the contrast control R6 through C47.

The contrast control varies the amplitude and couples the composite video signal to the base of Q2 through capacitor C3. Transistors Q2 and Q3 are complimentary direct coupled, common emitter amplifiers. The voltage gain (approximately 12) of the preamplifier stage is controlled by the feedback arrangement of R9, R10, R11, and R12. Resistors R7 and R8 provide the base bias voltage for Q2. Capacitor C4B is used for high frequency peaking.

The output of the video preamplifier stage is coupled to the video output stage through capacitor C4. Diode D2 clamps the video signal to approximately +0.7 volts (DC restoration) when a sync pulse turns on the sync amplifier Q11. The video output stage is connected in a cascade configuration. Transistor Q4 is a common emitter amplifier and Q5 is connected in a common base arrangement. Capacitors C7, C8, and resistor R16 are used for high-frequency compensation, and resistor R18 controls the gain of the stage to approximately 47. Diode D3 maintains the base of Q5 at -6.2 volts, while capacitor C5 filters the video signal variations from the base voltage. Resistor R13 provides a DC bias path for D2 and R19 and D4 are used to limit the current through the CRT.

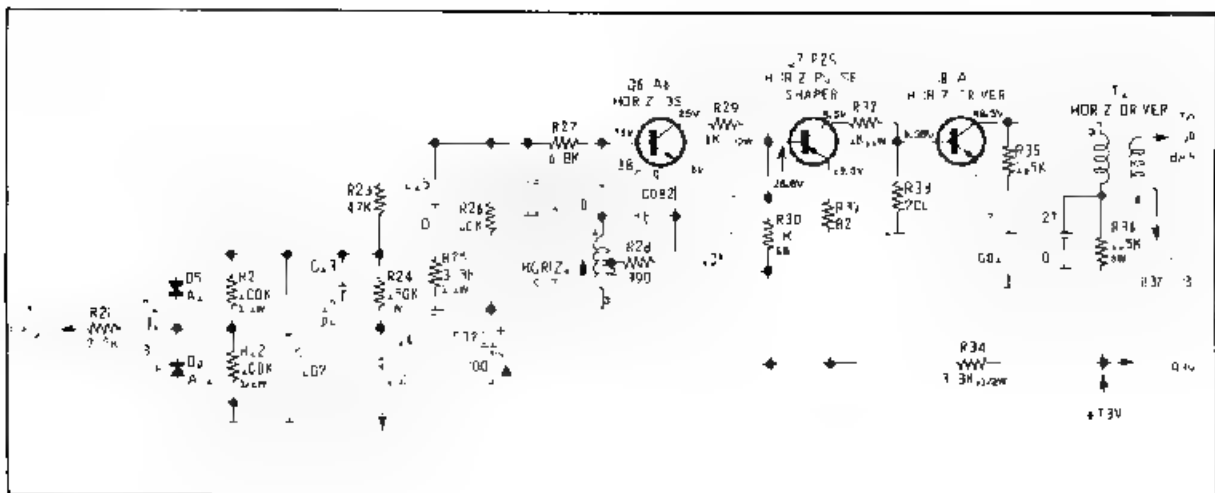


Figure 6-6 Motorola Monitor Horizontal Deflection Circuit

Capacitor C10 AC couples the video from the collector of Q3 to the cathode of the CRT. D4 turns off due to high beam currents. Resistor R17 is the collector load for Q7, and R15 provides the bias current for the zener diode D3. Capacitors C9 and C6 filter video frequencies from the -150 volt and $+12$ volt supplies. Resistor R14 and zener diode D1 are used to supply $+12$ volts for Q1, Q2, and Q3.

D. HORIZONTAL DEFLECTION CIRCUITS (See Figure 6-6)

Phase Detector (See Figure 6-7)

The phase detector consists of two diodes, D5 and D6, in a keyed clamp circuit. Two inputs are required to generate the required output, one from the horizontal sync amplifier, Q11, and one from the horizontal output circuit, Q9. The required output must be of the proper polarity and amplitude to correct phase differences between the input horizontal sync pulses and the horizontal time base.

The horizontal output (Q9) collector pulse is integrated into a sawtooth by R24 and C12. During horizontal sync time, diodes D5 and D6 conduct, which shorts C12 to ground. This effectively clamps the sawtooth on C12 to ground at sync time. If the horizontal time base is in phase with the sync waveform A, the sync pulse will occur when the sawtooth is passing through its AC axis, and the net charge on C12 will be zero (waveform B). If the horizontal time base is lagging the sync, the sawtooth on C12 will be clamped to ground at a point negative from the AC axis. This will result in a positive DC charge on C12 (waveform C). The positive polarity

causes the horizontal oscillator to speed up and correct the phase lag. Likewise, if the horizontal time base is leading the sync, the sawtooth on C12 will be clamped at a point positive from its AC axis. This results in a net negative charge on C12, which is the required polarity to slow the horizontal oscillator waveform D.

Components R23, C15, R25 and C17 comprise the phase detector filter. The bandpass of this filter is chosen to provide correction of horizontal oscillator phase without ringing or hunting. Capacitor C13 times the phase detector for correct centering of the picture on the raster.

Horizontal Oscillator

The horizontal oscillator employs the principles of the Hartley type oscillator. Its operating frequency is sensitive to its DC base input voltage, thus permitting the frequency of the oscillator to be varied by the output voltage of the phase detector. The main frequency determining components are L1, C19, and R28. The oscillator operates as a switch being biased alternately into saturation and cut off. The initial forward starting bias is supplied via R26.

Horizontal Pulse Shaper and Driver

The horizontal pulse shaper Q7 serves as a buffer stage between the horizontal oscillator and driver. Capacitor C20 and resistor R40 combine to shape the input waveform to the required duty cycle of 50%, which is necessary to drive the horizontal output stage.

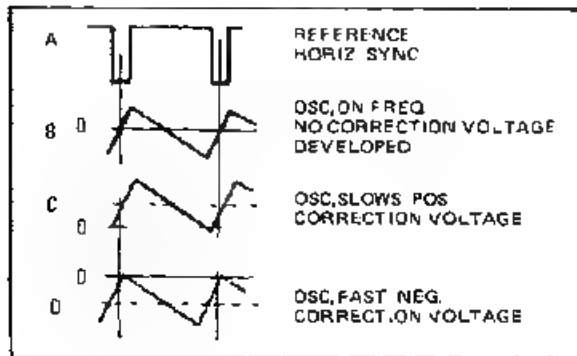


Figure 6-7 Motorola Monitor Horizontal Deflection Waveforms

The horizontal driver Q8 operates as a switch to driving horizontal output transistor Q9 through T1. Because of the low impedance drive and fast switching times, very little power is dissipated in Q8.

Resistor R35 and capacitor C21 provide damping to suppress ringing in the primary of T1 when Q8 goes into cut-off. Resistor R36 is used for limiting current in the collector of Q8, and C22 filters the horizontal frequency variations from the DC side of the transformer primary.

Horizontal Output (See Figure 6-8)

The secondary of T1 provides the required low drive impedance for Q9. Resistor R37 limits current in the base of Q9, while capacitor C23 provides additional reverse bias to keep Q9 turned off during the horizontal retrace pulse. Transistor Q9 operates as a switch which once each horizontal time period connects the supply voltage across the parallel combination of the horizontal deflection yoke and the primary of T2. The required sawtooth deflection current through the horizontal yoke is formed by the L-R time constant of the yoke and output transformer primary. The horizontal retrace pulse charges C27 through D8 to provide operating voltage for G2 of the CRT. Momentary transients at the collector of Q9, should they occur, are limited to the voltage on C27, since D8 will conduct if the collector voltage exceeds this value.

The damper diode D7 conducts during the period between retrace and turn on of Q9 to reduce retrace overshoot. Capacitor C28 is the retrace tuning capacitor. Capacitor C25 blocks DC from deflection yoke. Components R38 and C26 are damping components for the width and linearity coils. Capacitor C32D is charged through D10, developing the video output supply voltage.

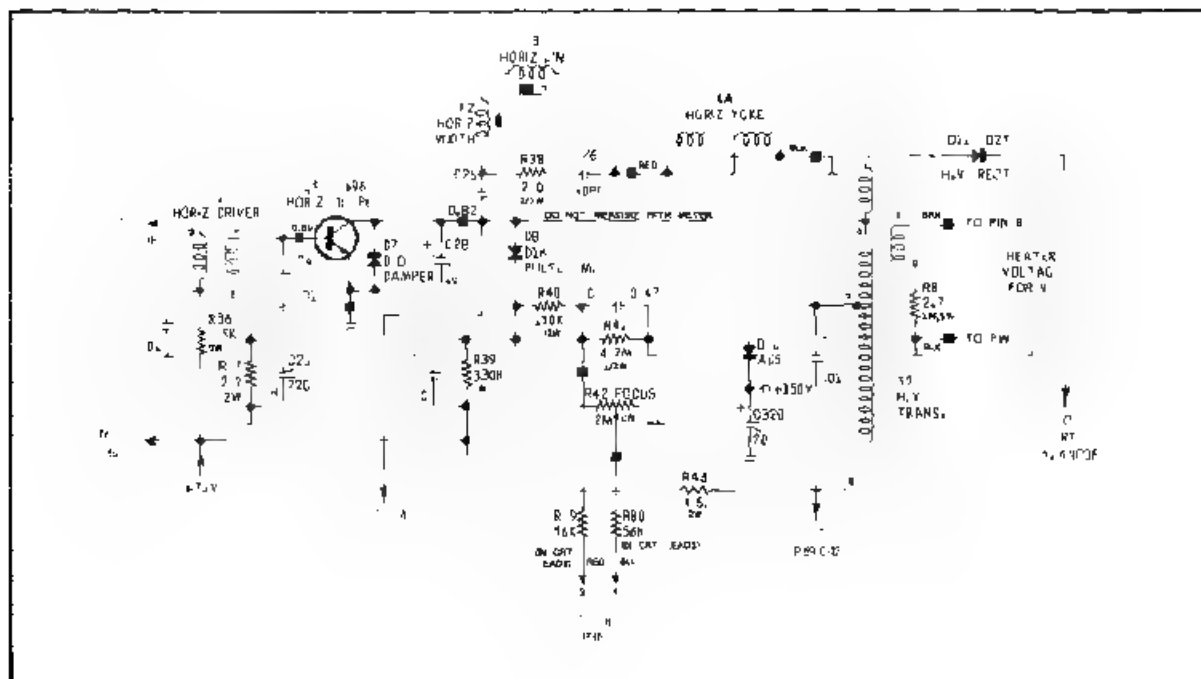


Figure 6-8 Motorola Monitor Horizontal Output Circuit

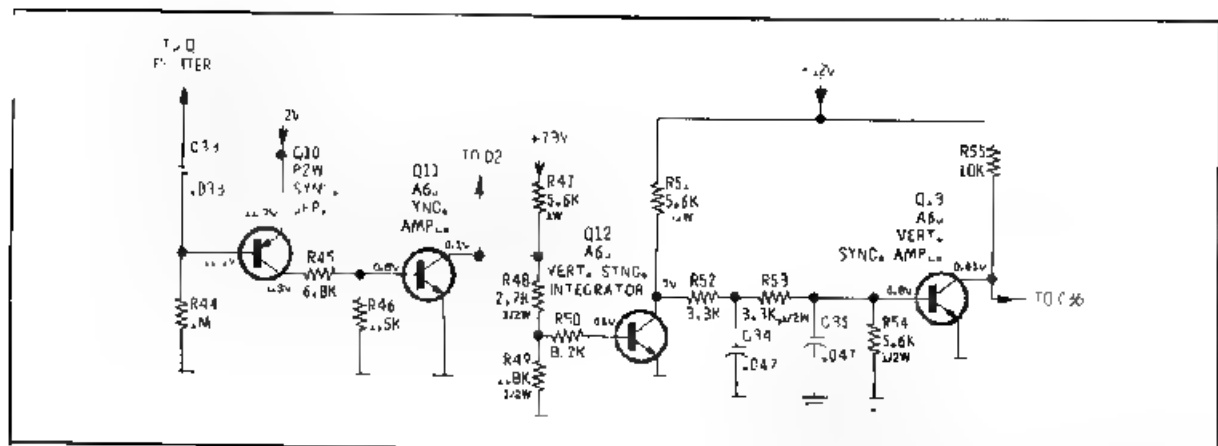


Figure 6-9 Motorola Monitor Sync Circuit

Sync Circuits (See Figure 6-9)

The video signal is coupled from the emitter of Q1 to the base of Q10 through C33. The negative-going sync tips turn on Q10 and are clamped to the value of the base voltage due to the base-emitter diode junction. The video information within the composite video signal, however, is less negative and Q10 remains off between each sync tip. Therefore the waveform at the collector of Q10 will contain only the composite sync pulse information.

Resistors R45 and R46 provide base bias for Q11. The composite sync pulses are amplified and inverted by Q11 where they are coupled to the vertical sync

integrator Q12, the horizontal phase detector and the video clamp diode D2. Resistors R47, R48 and R49, are the collector load for Q11 and also provide base bias for Q12. Resistor R50 limits current through the base-emitter junction of Q12, and R51 is its collector load. Components R52, C34, R53, C35, and R54 form a double integrator which removes the horizontal pulses from the composite sync signal, leaving the vertical pulses to be amplified by Q13 and coupled to the vertical oscillator.

Vertical Oscillator and Output (See Figure 6-10)

The vertical oscillator is a relaxation oscillator and operates at a free-running frequency that is set by

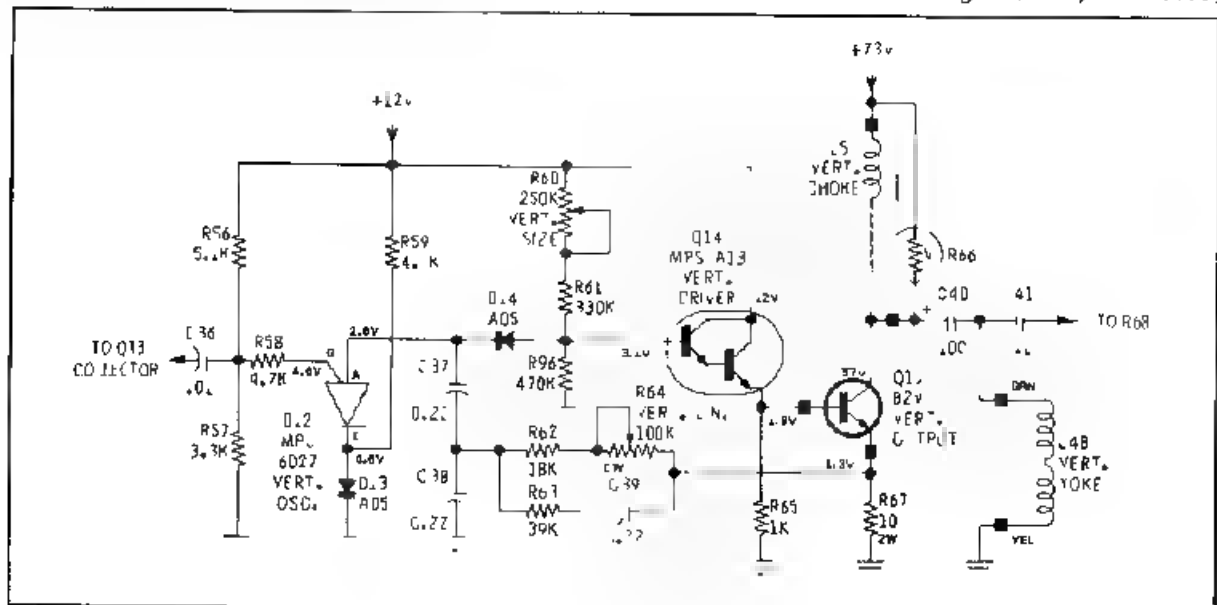


Figure 6-10 Motorola Monitor Vertical Oscillator Circuit

the value of resistors R56 and R57. The series combination of C37 and C38 charges through D14. R67 and R60 until D12 turns on. This occurs when the anode voltage of D12 exceeds the gate voltage by approximately 0.5 volts. When D12 conducts, C37 and C38 are discharged to nearly zero volts; then D12 turns off and the cycle repeats. The value of R61 and the setting of R60 determines the amplitude of the waveform.

Diode D14 provides a small incremental voltage above ground to overcome the forward base-emitter drop of Q14. D13 provides temperature compensation for the output stage. Resistor R96 provides a constant oscillator load for variations in input impedance of Q14. Transistor Q14 is an emitter-follower used to transform the high impedance drive sawtooth to a low impedance drive for Q15.

The vertical choke L5 acts as a current source during linear scan time and provides a high-voltage pulse to aid retrace when Q15 shuts off. To limit this pulse to a safe value, a varistor R66 is connected across the choke.

Since the impedance of the choke decreases when the collector current of Q15 increases, severe vertical non-linearity will result unless some compensation is employed.

Resistors R64 and R62 couple the emitter voltage of Q15 to the junction of C37 and C38. This path is resistive, and the waveform coupled back will be integrated by C38. This results in a pre-distortion of the drive sawtooth. This is done to compensate for the non-linear charging of C37, C38 and the changing impedance of C5. An additional feedback path through R63 and C39 serves to optimize the drive waveshape for best linearity. Capacitor C40 couples the signal to the vertical yoke winding and blocks DC.

Spot Kill (See Figure 6-11)

The spot kill circuitry is used to reduce the effect of the electron beam concentrating on one area of the CRT after the monitor is turned off. The circuitry is accomplished by raising the arm of potentiometer R73 to the +150 volt level and, therefore, increasing the brightness to maximum to dissipate the high-voltage charge that normally remains in the CRT.

When the monitor is operating, transistor Q20 is on and its collector is near zero volts. Capacitor C44 charges through the base-emitter junction of Q20 and R97. Resistor R72 provides the base bias voltage required to keep Q20 on. When the monitor is turned

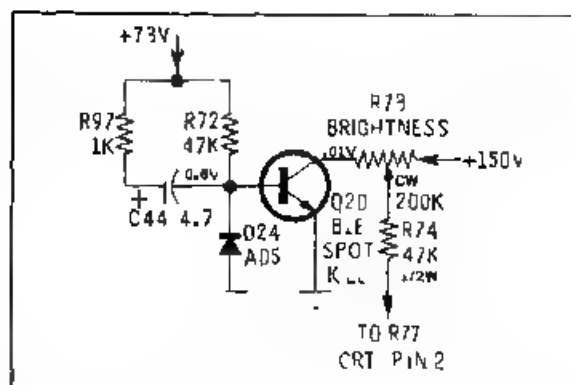


Figure 6-11 Motorola Monitor Spot Killer Circuit

off, the falling +73 volts is coupled to the base of Q20 to turn off the transistor causing its collector voltage to rise to approximately +150 volts. Diode D24 prevents the negative voltage swing at the base of Q20 from exceeding the reverse voltage rating of the transistor.

Blanking Amplifier (see Figure 6-12)

The blanking amplifier combines both the vertical and horizontal retrace pulses to turn off the electron beam in the CRT once every horizontal line and once every vertical field.

Capacitor C41 couples the vertical retrace pulses and capacitor C31 couples the horizontal retrace pulses to the blanking amplifier. Resistor R68 determines the amplitude of the vertical pulses, while R69 determines the amplitude of the horizontal pulses. Capacitor C42 bypasses R69 to couple the leading and trailing edges of the horizontal retrace pulses to the amplifier. Resistor R70 allows C41 to discharge when the retrace pulses swing below zero volts. Diode D15 prevents the retrace overshoot from exceeding the reverse voltage rating of Q20. Resistor R71 permits Q20 to turn off between retrace pulses, while R75 and R76 provide the collector voltage for Q20. Capacitor C43 couples the blanking pulses to the control grid of the CRT.

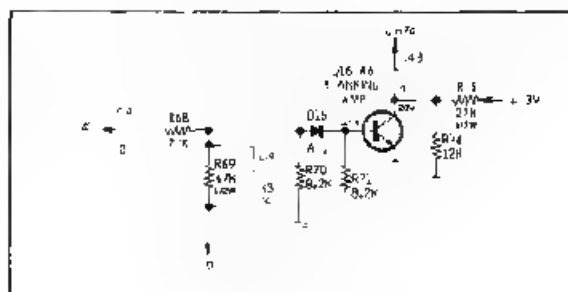


Figure 6-12 Motorola Monitor Blanking Amplifier Circuit

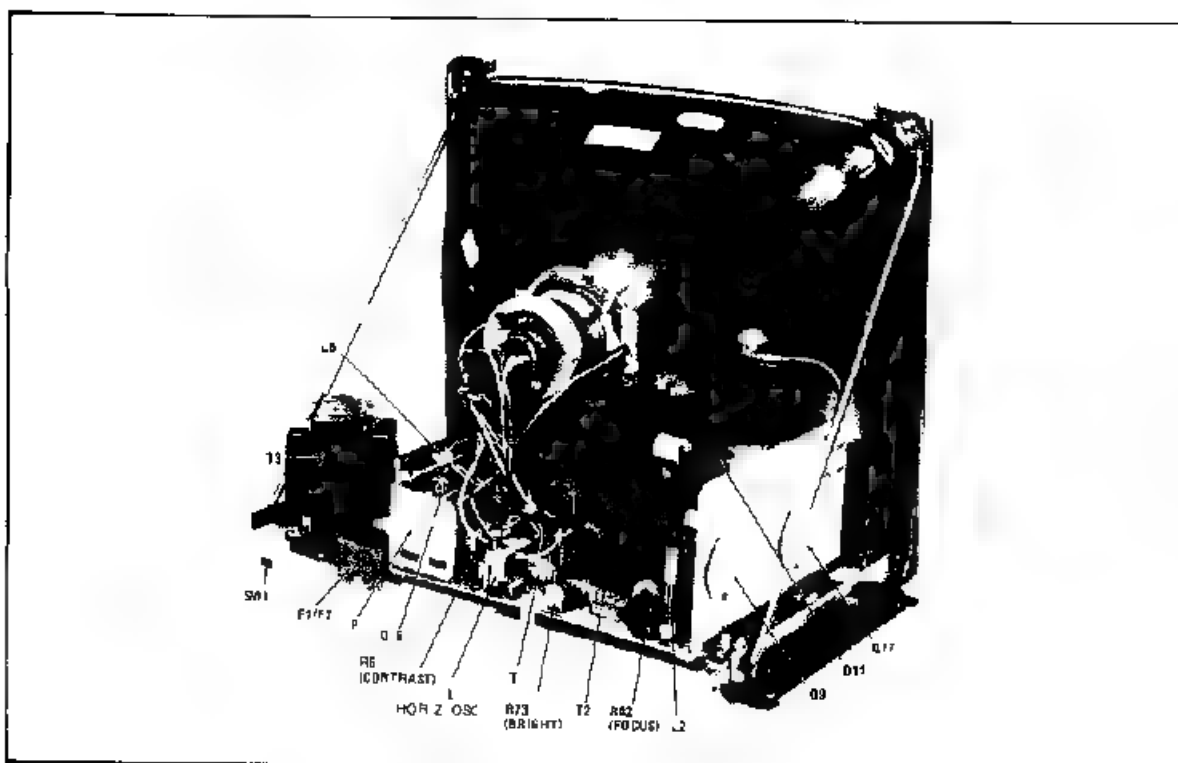


Figure 6-13 Motorola Monitor Chassis Rear View --Component Location

Figure 6-14 Motorola Monitor Circuit Board Detail—Solder View

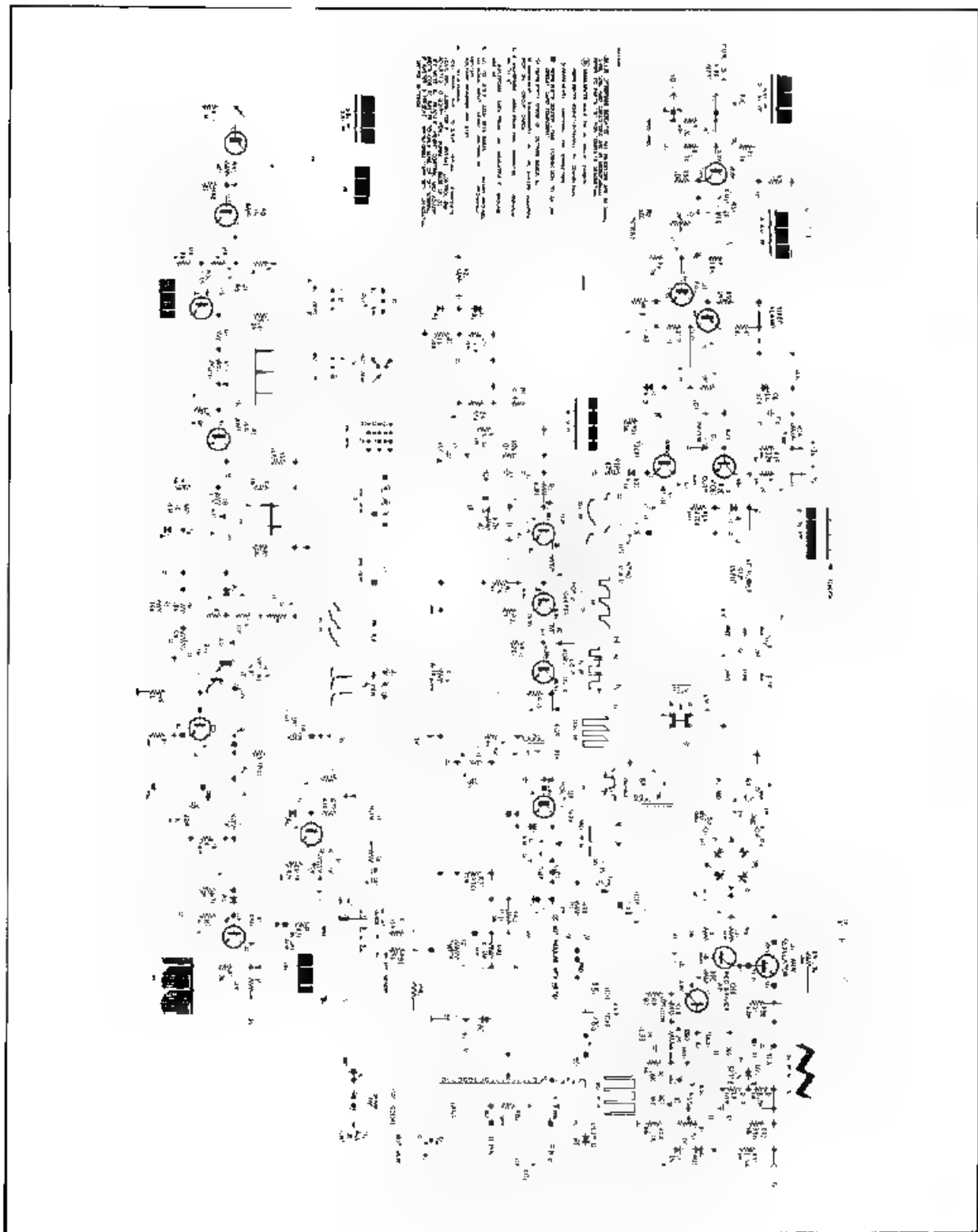


Figure 6-15 Motorola Monitor Schematic Diagram

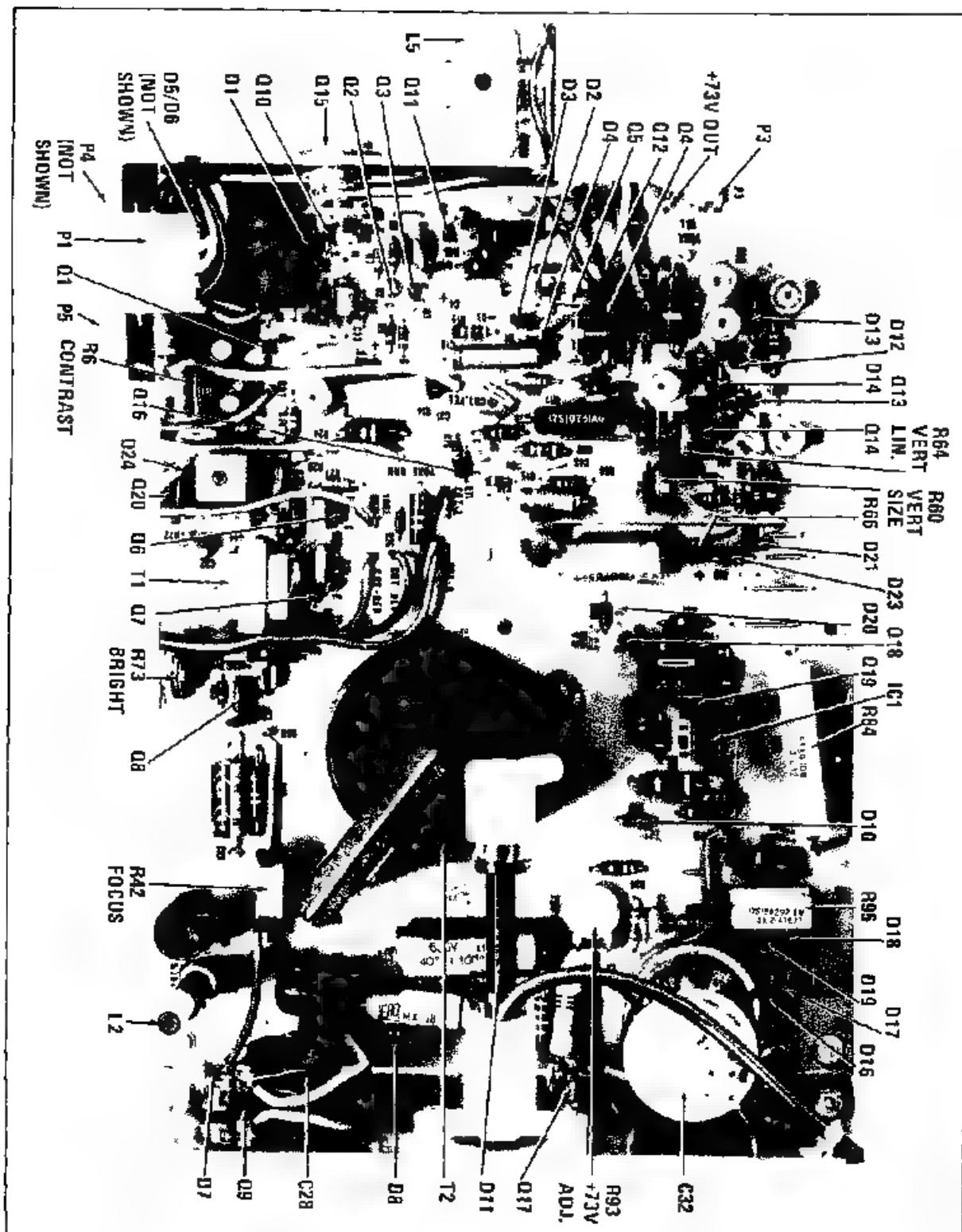


Table 6-2 Motorola Replacement Part Numbers

REF NO	PART NUMBER	DESCRIPTION	REF NO	PART NUMBER	DESCRIPTION
Capacitors: All values are in Microfarads unless otherwise noted			C31	8S10191B98	01 10% 250V, Poly
C1	23S10255A27	47, 50V, Lytic	C32	23S10255B73	20/200, 400/125, 600/100, 200/50, Lytic
C2	21S135660	05, +80 20 Z5V 50V, Cer Disc	C33	8S10191A5	033 10%, 160V, Poly
C3, C4	23S187A26	22, 25V, Lytic	C34, C35	8S10191A32	047 10%, 250V, Poly
C5	21S180E60	01 +80 20 Z5V 50V Cer Disc	C36	21S180E60	01 +80 20, Z5V, 50V Cer Disc
C6	21S135660	05 +80 20, Z5V 50V, Cer Disc	C37 38 39	8S10191B67	0 22 10%, 250V, Poly
C7	21S131625	330pf, 10%, X5F 500V Cer Disc	C40	23S10255A60	100 63V, Lytic
C8	21S 80B87	220pf 10%, X5F 500V Cer Disc	C41	8S10212B16	0 1 20% 400V Mtlz Poly
C9	8S10191B99	015 10% 250V Poly	C42	21S180C82	0 33, 10%, N150, 500V Cer Disc
C10	8S10212B18	0 22, 10%, 400V, Mtlz Poly	C43	8S10191B67	0 22, 10% 250V Poly
C11	21S131625	330pf, 10%, X5F 500V, Cer Disc	C44	23S10255B28	4 7 100V Lytic
C12	21S180C41	0027 10%, Z5F 500V Cer Disc	C45	8S10191B90	.033 10%, 250V, Poly
C13	21S180C02	10pf, 10% N150, 500V Cer Disc	C46	21S132492	.01 +80-20, Z5V 100V Cer Disc
C14	21S180D34	005, 20% Z5F 1Kv Cer Disc	C47	23S10255B63	100 10V, Lytic
C15	23S10229A32	1 0, 16V Lytic	C48	21S180D56	47pf, 10% N750, 100V Cer Disc
C17	8S10191B90	033, 10%, 250V Poly	C49	21S180B31	001 10% X5F 500V Cer Disc
C18	8S10299B28	01 10%, 100V Polycarb	Diodes:		
C19	8S10299B29	0082, 10%, 100V Polycarb	D1	48S10813A03	Diode Silicon Zener 1N5242
C20	8S10191B98	01, 10%, 250V Poly	D2	48D67120A13	Diode A13
C21	21S180B51	001, 10%, X5F 500V, Cer Disc	D3	48S10813A01	Diode Silicon Zener 1N5234B
C22	8S10191B98	01 10% 250V Poly	D4	48S191A02	Rectifier Silicon 91A02
C23	23S10255B50	150, 10V, Lytic	D5 D6	48D67120A11	Diode A11
C24	21S180B51	001, 10% X5F 500V Cer Disc	D7	48S134921	Diode Damper, D1D
C25	8S10299B27	0 82 10% 200V Mtlz Polycarb	D8	48S134978	Diode Pulse Lim, D1K
C26	21S131625	330pf 10% X5F 500V, Cer Disc	D10	48S191A05	Rectifier Silicon 91A05
C27	8S10212A11	1 0, 10% 630V Mtlz Poly	D11	48S137114	Rectifier H V D2Y
C28	8S10571A06	01, 5% 1200V, Polyprop Foil	D12	48S137638	Vert. Osc., MPL6027
C29	8S10212B53	0 47 10% 630V, Mtlz Poly	D13, D14	48S191A05	Rectifier Silicon 91A05
			D15	48D67120A11	Diode, A11
			D16 D17 D18, D19	48S191A05	Rectifier Silicon, 91A05
			D20	48S10813A02	Diode Silicon Zener, 1N5231B
			D2	48S10813A03	Diode, Silicon Zener, 1N5242
			D22	48D67120A11	Diode, A11
			D23 D24	48S191A05	Rectifier Silicon 91A05

Table 6-2 Motorola Replacement Part Numbers

Ref No	Part No	Description	Ref No	Part No	Description
Fuses:			R60	18D25245A29	Vert Size, 250k
F1, F2	655138269	Fuse, 0.8A -250V	R64	18D25245A31	Vert Lin, 100K
Integrated Circuits:			R66	65T0201A04	Varistor, 1 ma 120V 0.5W
IC1	51510732A01	Ref Ampl, T3F	R73	18D25245A28	Control Brightness, 200K
Coils/Chokes:			R84	175135589	150, 10%, 10W
L1	24C25448A01	Coil Horiz Osc	R93	18D25245A21	Control -73V out Adj, 2.5K
L2	24D25603A09	Coil Horiz Width	R95	10731A03	1.5k, 10%, 5W
L3	24D25248A14	Coil Horiz Lin	Switches:		
L4	24D25261A09	Coil Defl (M5000-155, M5010-155)	SW1	40S10624A07	Switch, Slide D.P.D.T
L4	24D25261A10	Coil Defl (M7000-155, M7010-155)	Transformers:		
L5	25D25221C12	Choke, Vertical	T1	25D25221A05	Horiz Driver
Transistors:			T2	24D25240B23	H.V. Transformer
Q1	48S137171	Emitter Follower, A6H	T3	25D25239B20	Transformer Power (M5010-155, M7010-155)
Q2	48S137172	Video Pre-Ampl, A6J	T3	25D25239B30	Transformer Power (M5000-155, M7000-155)
Q3	48S137127	Video Pre-Ampl, P25	Misc. Electrical Parts:		
Q4	48S134952	Video Driver, A2J	V1	96S241A01	19"-CRT, Type 19VARP4 (M5000/M5010)
Q5	48S137476	Video Output, B1E	V1	96S10848A01	23"-CRT, Type M22VATP4 (M7000, M7010)
Q6	48S137172	Horiz Osc, A6J	Mechanical Parts:		
Q7	48S137127	Horiz Pulse Shaper, P25		9B25456A01	Block Fuse (F1, 2)
Q8	48S137093	Horiz Driver, A5F		42D25158C01	Clamp, Defl. Coil
Q9	48S137570	Horiz Output, B2L		26S10251A08	Heat Sink (Q5)
Q10	48S137173	Sync Separator, P2W	P1	15S10183A69	Housing Connector Female (12-Contact Less Contacts)
Q11	48S137172	Sync Ampl, A6J		39S10184A67	Contact Plug 5 Req'd M5000, M7000, 9 Req'd, M5010, M7010
Q12	48S137172	Vert Sync Integrator, A6J	P2	15S10183A82	Housing Connector, Male (3-Contact Less Contacts), M5000/M7000
Q13	48S137172	Vert Sync Amp, A6	P2	15S10183A81	Housing Connector, Female (3-Contact, Less Contacts), M5010/M7010
Q14	48S137639	Vert Driver, MPS A13		39S10184A67	Contact Plug 3 Req'd for P2
Q15	48S137596	Vert Output, B2V	P3	28S10586A35	Header Connector, 2-Contact
Q16	48S137172	Blanking Ampl, A6J			
Q17	48S137368	Regulator, A8W			
Q18	48S134952	Reg. Driver, A2			
Q19	48S137476	Reg. Buffer, B1E			
Q20	48S137476	Spot k.t., B1E			
Resistors/Controls:					
NOTE: Only power or special resistors are listed. Use the description when ordering standard values of fixed resistors up to 2 watts.					
R6	18D25245A27	Control, Contrast 500			
R14	175135204	100, 10%, 5W			
R17	17510731A01	3.9k, 5%, 5W			
R36	17510130B07	1.5k, 10%, 3W			
R42	18D25218A14	Control, Focus 2M			

Table 6-2 Motorola Replacement Part Numbers

REF NO	PART NUMBER	DESCRIPTION	REF NO	PART NUMBER	DESCRIPTION
P4, P5	15S10183B12	Housing, Connector, Female (3-Contact, Less Contacts) M5010, M7010		14B25459A01	Insulator, Fuse Cover F1, 2)
	39S10184A84	Contact Plug, 3 ea Req'd for P5 M5010, M7010		14A562353	Insulator, Mica Q9, Q15, Q17)
S2	15S10183A81	Housing, Connector, Female (3-Contact, Less Contacts) M5000, M7000		14C25230A01	Insulator, Molded (On D11 Body)
S2	15S10183A82	Housing, Connector, Male (3-Contact, Less Contacts, M5010, M7010)		14S10157A30	Insulator, Nylon (2 Req'd), Mtg. P.C. Board
	39S10184A64	Contact Receptacle 3 Req'd for S2		14S10550A02	Insulator, Transistor Cover Q9, Q15, Q17
S3	15S10183A94	Housing, Connector, Female (2-Contact, Less Contacts)		3S136050	Screw, Tpg. 6-20x1/2 C.L.L. Pan. (Mtg. Q9, Q15, Q17 and D11 Socket)
	39S10184A72	Contact Receptacle 3 Req'd for S3		9D25470A01	Socket, CRT Incl's. R77, R7B, R79, R80
				9D25201A01	Socket, H.V. and CRT Anode
				9C63825A03	Socket, Power Transistor Q9, Q15, Q17)
				41D65987A01	Spring Special, CRT Aquadag Cnd

TEC VIDEOELECTRONICS INC. **SERVICE MANUAL**

A. GENERAL

TM-600 and TM-623 is a television monitor for video games. It is designed for operation either from a power supply of 115 volts 50-60 Hz AC or 230 volts 50-60 Hz AC. The complete monitor incorporates a picture tube, an integrated circuit, 20 silicon transistors, 18 silicon diodes, 2 germanium diodes, and a high-voltage selenium diode.

This model is equipped with 5V 3A power supply for the operation of the TTL control board and operation double pulse type AFC circuit to obtain a stable picture.

B. SPECIFICATIONS

Power Supply Input

115 volts/230 volts 50-60 Hz $\pm 10\%$

Power Consumption

60 watts

Video Input

0.5 volts composite P/P for 100 volts

2.5 volts P/P maximum

Sync negative at input

Picture Tube

19" 500 mm, 114° deflection for Model TM-600

23" (584.2 mm) 114° deflection for Model TM-623

Integral implosion protection

High Voltage

18 KV nominal at 0 microamperes beam current

Horizontal Retrace Time

12 microseconds maximum

Resolution

500 lines minimum at picture center

Scanning Frequency

Horizontal 15.750 Hz ± 500 Hz

Vertical 50-60 Hz

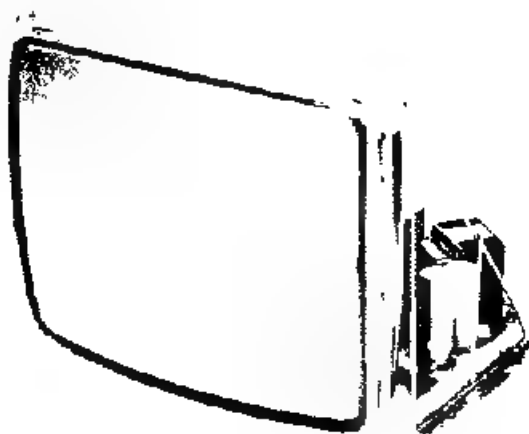
Tone Burst Amplifier

5 watts peak output with TTL drive at nominal line, fully adjustable 4 watts peak output at low line

Environment

Operation: Maximum ambient temperature 50°C (122°F)

Storage: Temperature range from -40°C to +65°C



Model TM-600 and TM-623 Monitors

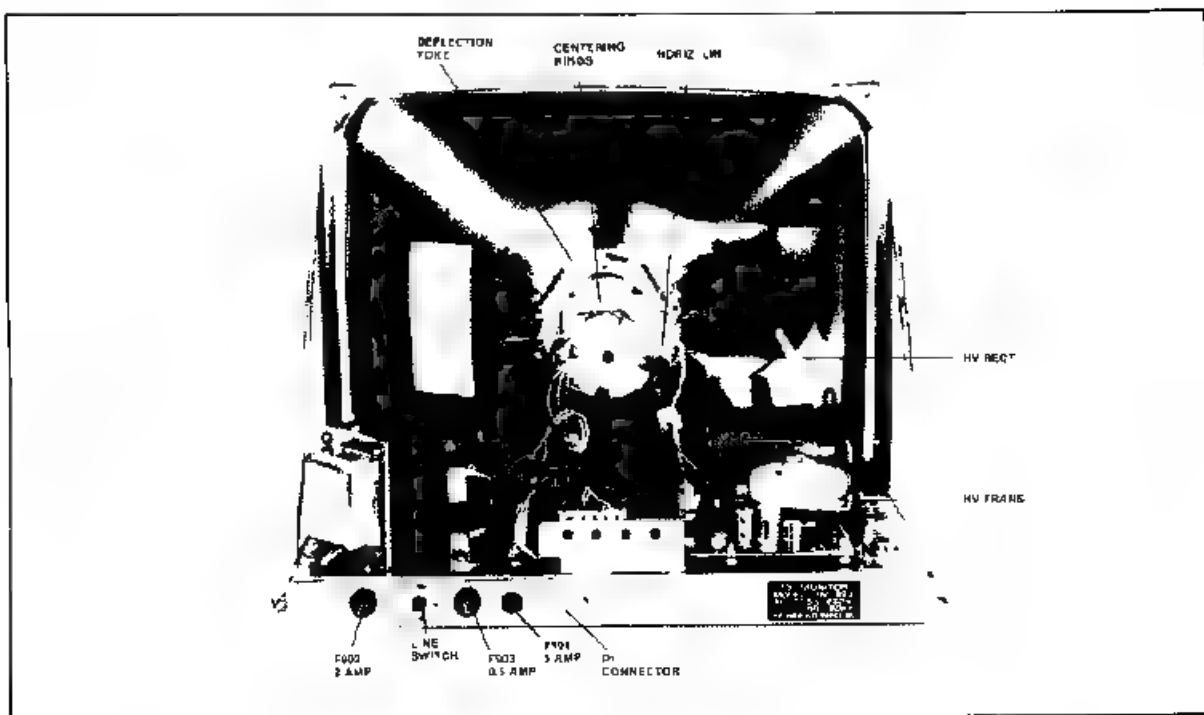


Figure 6-17 TEC Monitor Chassis, Rear View

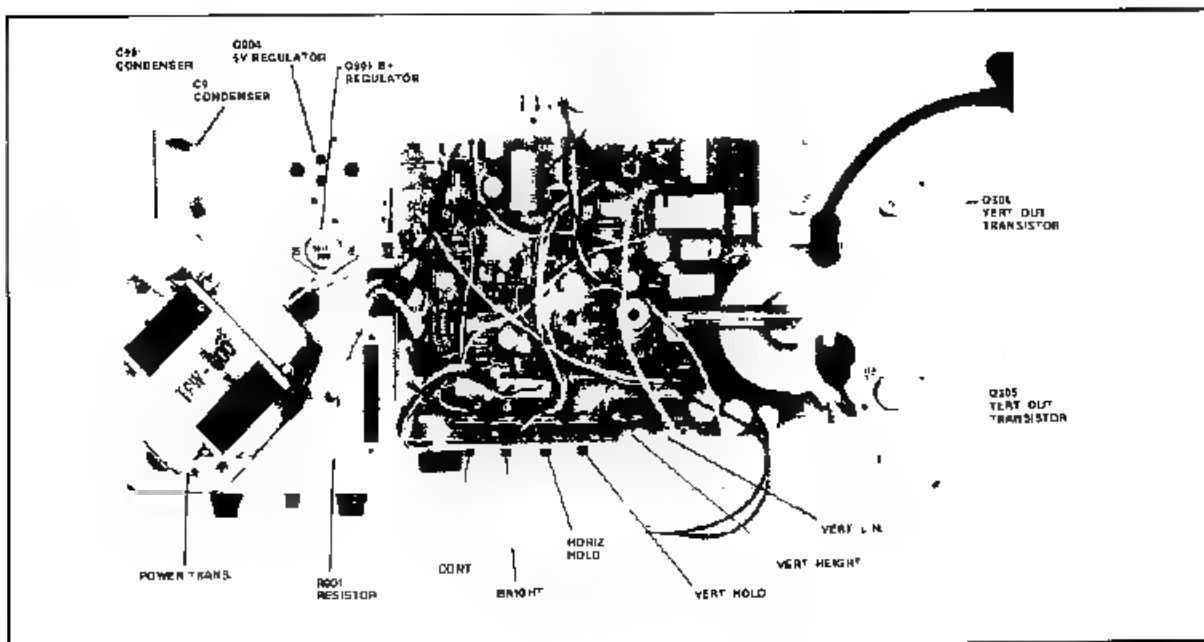


Figure 6-18 TEC Monitor Chassis, Top View

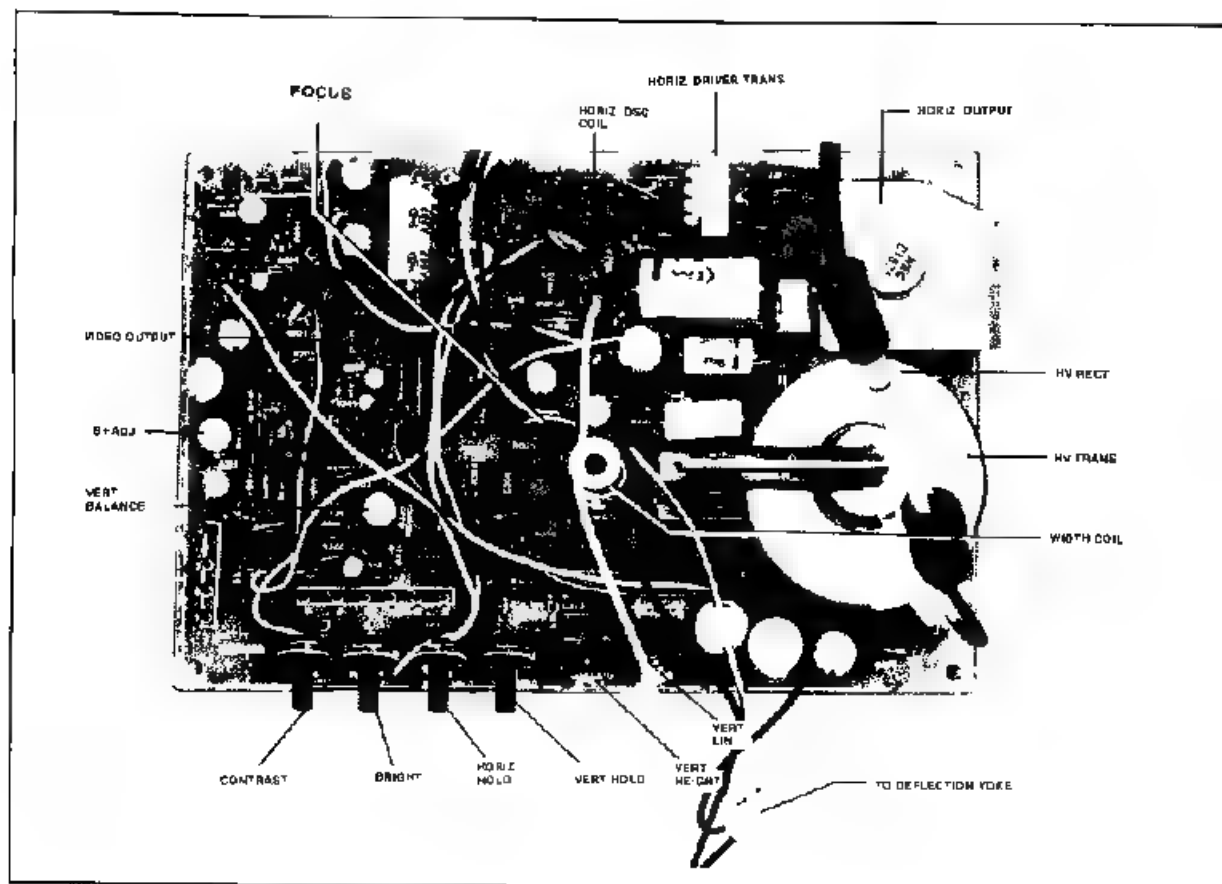


Figure 6-19 TEC Monitor Printed Circuit Board, Top View

Table 6-3 TEC Monitor Replacement Parts Numbers

Ref No	Part No	Description	Ref No	Part No	Description
Electrical Parts:			Q103	5300500201	MPS9700U Vert Amp
PCB1	2215303600	Main PCB		or MPS834	
A801	485TM60003	CRT PCB	Q104	4310410030	25C1106 Vert Output
Transistor and IC			Q305		or 2N6307
Q200	5310500202	MPS9700T 1st Video Amp	Q400	5310500202	MPS9700T Phase Inv
	or MPS834			or MPS834	
Q201	5310500261	MPS9750T 2nd Video Amp	Q401	5310500202	MPS9700T Horiz Osc
	or MPS4356			or MPS834	
Q202	5310500410	2N6558 Video Output	Q402	5310500410	2N6558 Horiz Amp
	or MPSL 10			or M E9742	
Q301	5310500261	MPS9750T Sync Separator		or 2N4354	
	or MPS4356		Q403	5310400040	25C1875 Horiz Output
Q302	5310500201	MPS9700U Vert Osc		or M 205	
	or MPS834		*C901	5310400030	25C1106 Power Regulator
				or M 3430	

Table 6-3 TEC Monitor Replacement Parts Numbers

Ref No	Part No	Description	Ref No	Part No	Description	
Q902	5310500410 or 5310500070	2N6558 MP5-L04	Regulator Amp	T401	589514015	TLN-506BX Horiz Osc
Q903	5310500280	LM1796 or MP5-D01	Reference Amp	T402	589518012	TLN-519 Horiz Drive
Q904	5310500430	MJ2935	5V Regulator	* T403	589517017	TFB-1006AS F B T
CRT and Diode			* T901	589519021	TPW-600 Power Trans	
* V801	5380000060	500SB4	CRT	Resistors		
D203	5340200280	MR9712 or IN4004	Silicon Diode L V Rectifier	R201	RD-4L471J	470 ohm J ¼ W
D204	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R202	RD-4L223J	22 K ohm J ¼ W
D205	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R203	RD-4L563	56 K ohm J ¼ W
D206	5340200430	IN4148 or IN4002	Silicon Diode Blanking Clip	R204	RD-4L471J	470 ohm J ¼ W
D207	534020280	MR9712 or IN4004	200V Rect	R205	RD-4L332J	33 K ohm J ¼ W
D301	5340200260	MR-9701	Rectifier Silicon Diode	R206	RD-2L823J	82 K ohm J ½ W
D401	5340100040	AA143	Phase Det	R207	RD-4L560J	56 ohm J ¼ W
D402	5340100040	AA143	Phase Det	R208	RD-4L102J	1 K ohm J ¼ W
D403	5340200300	MR9722	Damper	R210	RS-029562	5.6 K ohm J 2 W
* D404	5340400120	TV20-2K80J or HS307b	H V Rectifier	R215	RD-42101	1 K ohm J ¼ W
D801	5340200290	MR9713	400V Rectifier	* R216	RD-4L701	100 ohm J ¼ W
D901	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	* R217	RD-4L470	47 ohm J ½ W
D902	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R218	RD-4L223	22 K ohm J ¼ W
D903	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R219	RD-4L563	56 K ohm J ¼ W
D904	5340200270	MR9704 or IN4005	Rectifier Silicon Diode	R220	RD-4L102	1 K ohm J ¼ W
D906	5340300220 or 5340300310	IN5858A IN6002A	Zener Diode	R221	RD-4L102	1 K ohm J ¼ W
D907 D908 D909 D910	5340200690	MDA970-1	Rectifier	R222	RD-2L102	1 K ohm J ½ W
Coils and Trans:			R223	RD-2L102	K ohm J ½ W	
* L401	589515015	TDY1005	D Y Coil	R224	RD-2L122	1.2 K ohm J ½ W
L402	589512015	HCH1005	Horiz Choke Coil	* R226	RS01P101J	100 ohm J 1 W
L403	589512012	HC2-035	Choke Coil	R227	RD-2L123J	12 K ohm J ½ W
L404	589512012	HC2-035	Choke Coil	R228	RD-2L105J	15 K ohm J ½ W
L405	589514013	AZ-9177DM	Width Coil	R229	RD-4M681	680 ohm J ¼ W
L406	589514016	LH-15J54	Lin Coil	R302	RD-4M331J	330 ohm J ¼ W
				R303	RD-4L562J	56 K ohm J ¼ W
				R304	RD-4M102J	1 K ohm J ¼ W
				R308	RD-4M104J	100 K ohm J ¼ W
				R309	RD-4M155T	1.5 M ohm J ¼ W
				R310	RD-4M332J	3.3 K ohm J ¼ W
				R311	RD-4M563J	56 K ohm J ¼ W
				R312	RD-4L182J	18 K ohm J ¼ W
				R313	RD-4L153	15 K ohm J ¼ W
				R314	RD-4L183	18 K ohm J ¼ W
				R315	RD-4L203	20 K ohm J ¼ W
				R316	RS-2P333J	33 K ohm J ½ W
				R327	RD-4L104	100 K ohm J ¼ W
				R320	RD-4L124	120 K ohm J ¼ W

Table 6-3 TEC Monitor Replacement Parts Numbers

Ref. No.	Part No	Description
R322	RD-4L224J	220 K ohm J ¼ W
R323	RD-4L433J	43 K ohm J ¼ W
R324	RD-4L471J	470 ohm J ¼ W
R326	RD-4L152J	15 K ohm J ¼ W
R339	RD-4L101J	100 ohm J ¼ W
R331	RD-4M331J	330 ohm ¼ W
R332	RD-4L102J	1 K ohm J ¼ W
R333	RS01P682J	6.8 K ohm 1 W
R334	RD-2L183J	18 K ohm, ½ W
R336	RD-4L221J	220 ohm, ½ W
R337	S160122901	2.2 ohm, ½ W
R338	RS-2P150	15 ohm ¼ W
R339	S160112901	1.2 ohm ½ W
R340	RS01P220T	22 ohm 1 W
R401	RD-4L153J	75 K ohm ¼ W
R402	RD-4L821J	820 ohm ¼ W
R403	RD-4M561J	560 ohm ¼ W
R404	RD-4M103J	10 K ohm J ¼ W
R405	RD-4M103J	10 K ohm J ¼ W
R406	RD-4L272J	2.7 K ohm J ¼ W
R407	RD-4L681J	680 ohm J ¼ W
R408	RS02P682J	4.7 K ohm J ½ W
R419	RD-4L270J	27 ohm ¼ W
R410	RD-4L182J	1.8 K ohm J ¼ W
R411	RD-4L151J	150 ohm J ¼ W
R412	RD-4L561J	560 ohm J ¼ W
R413	RS01P682J	6.8 K ohm J 1 W
R414	RD-2L221J	220 ohm J ½ W
R415	S160122903	2.2 ohm J 1 W
R416	RD-2L569J	5.6 ohm J ½ W
R417	RS02P182J	1.8 K ohm J 2 W
R418	RS01P123J	12 K ohm J 1 W
*R420	RX05P220	22 ohm J 5 W
*R421	RD-2L569J	5.6 ohm J ½ W
R422	RD-4L153J	47 ohm J 1 W
R425	RD-4L153J	15 K ohm J ¼ W
R426	S5337153	15 K ohm J ¼ W
R802	RD-2L154J	150 K ohm J ¼ W
R804	RD-2L474J	470 K ohm J ½ W
R811	RD-2L561J	2MΩ ¼ W
*R901	RX20P251J	250 ohm J 20 W
R902	RD-2L101J	1 K ohm J ½ W
R903	RD-2L123J	12 K ohm J ½ W
R904	RD-2L123J	12 K ohm J ½ W
R905	RD-2L221J	22 K ohm J ½ W
R906	RD-2L563J	56 K ohm J ½ W
R907	RD-2L163J	56 K ohm J ½ W
R909	RD-2L682J	6.8 K ohm J ½ W
Controls:		
R211	S53102005E	1 K ohm Contrast
R319	S53104005B	100 K ohm Vert Hold
R321	S53124008B	220 k ohm Vert Height
R327	S53472008B	4.7 K ohm Vert Linearity
R335	S53102007B	1 K ohm Vert Balance
R427	S53303005B	30 K ohm Horiz Hold
R803	S53254005B	250 K ohm Bright
R805	S53205005B	2 M ohm Focus
R908	S53472007B	4.7 K ohm B + ADJ
Capacitors:		
C201	CE2C1C470	47 mF 16V
C202	CE2C1F101	100 mF 25V
C203	CE2C1C220	22 mF 16V
C204	CE2C1H101	100 mF 35V
C205	CE2C1C220	22 mF 16V
C206	CE1S1H561K	560 pF K 50V
C207	CE2C0J221	220 mF 6.3V
C208	S270322401	0.22 mF M 400V
C209	CE2C2F229	2.2 mF 315V
C210	CE2G1H220	22 mF 35V
C211	CE2C1H339	3.3 mF 50V
C213	CK1F2H102K	0.001 mF 500V
C220	CE2G2F220	2.2 mF 250V
C301	CQ1M1H473K	0.047 mF K 50V
C304	CK1B1H391K	470 pF K 50V
C305	CE2G1H478	0.47 mF 50V
C306	S6405333	0.033 mF K 50V
C307	CQ1M1H562K	0.0056 mF K 50V
C308	CQ1M1H273K	0.027 mF K 50V
C309	CQ1M1H123K	0.012 mF K 50V
C311	CQ1M1H124K	0.12 mF K 50V
C312	CQ1M1H392K	0.0039 mF K 50V
C313	D55D1C279M	2.2 mF 16V
C314	CQ1M1H474J	0.47 mF 50V
C315	CQ1M1H333K	0.033 mF K 50V
C316	CF2C1A470	47 mF 10V

Table 6-3 TEC Monitor Replacement Parts Numbers

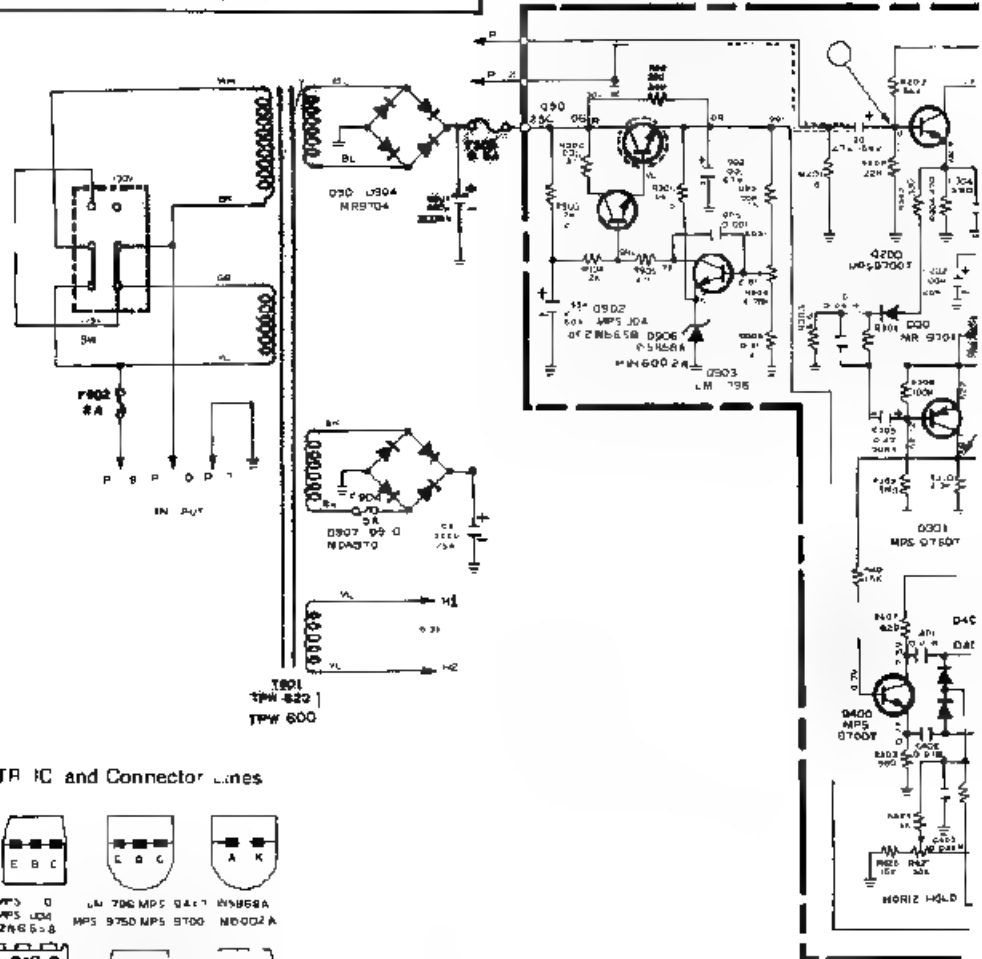
Ref. No	Part No.	Description	Ref No	Part No.	Description
C317	CE2C2A101	100 mF 100V	Fuses:		
C318	CK1E2H103K	0.01 mF 500V	*F902	6990620011	250V 2 Amp
C319	5270310301	0.01 mF 630V	*F903	5990610013	250V 0.5 Amp.
C401	CQ1M1H103K	0.01 mF K 50V	F904	5990630010	10V 5 Amp
C402	CQ1M1H103K	0.01 mF K 50V	Mechanical Parts:		
C403	CQ1M1H393K	0.039 mF K 50V	*K001	22-463020	Male-N Lock Connector (AMP)
C404	CK1B2H151	150 mF 500V		60085005	Edge Connector (Molex)
C405	CE2G1H339	3.3 mF 50V		S-A3915	Transistor Socket (SMK)
C406	CQ1M1H104K	0.1 mF K 50V	*TM60085001		Fuse Holder
C407	CQ1M1H223K	0.022 mF J 50V	or *TM60085001		Fuse Holder
C408	CQ1M1H683K	0.068 mF J 50V	K005	1-380R26-0	Stand-Off Fastener (AMP)
C409	CE2C1F470	47 mF 25V	P401	PE19-564	4P Plug Assy (Yoke Line)
C410	CK1B2H681K	680 pF K 500V	P402	PE19-1570	4P Recept Assy (Yoke Line)
C411	CK1B2H222K	0.0022 mF K 500V	P403	PE19-1571	3P Connector Assy (Video Input)
C412	CK1B1H152K	0.0015 mF K 50V	A621	PE19-1572	4P Connector Assy (Q901 Line)
C413	CK1B1H102K	0.001 mF K 50V	A631	PE19-1573	6P Connector Assy (Q304 Q305 Line)
*C414	CK1B3D471K	470 pF K 2kV	P406	PE19-1574	2P Plug Assy (Heater Line)
C415	CQ1M2A104K	0.1 mF K 100V	P407	PE19-1575	2P Recept Assy (Heater Line)
*C416	5270333201	0.0033 mF 15kV	TE401	PE19-1576	Terminator 6 Pin
C417	CE2C2C101	10 mF 160V	F001	135431015	Ground Plate
C418	5270333401	0.33 mF K 200V	F001	22-164001	Frame
C419	56635101	100 mF 35V	F003	54320011	Plate Heat Sink A
C420	56625471	470 mF 25V	Q403/D	54320011	Plate Heat Sink C
C801	5270356302	0.056 mF K 630V	<div>NOTE Design and specifications are subject to change without notice. 2 — Indicates + 5% tolerance K — Indicates +10% tolerance M — Indicates +20% tolerance</div>		
*C901	5240700400	450 mF 200V			
C902		00 mF 160V			
C904	F2C2C229	2.2 mF 160V			
C905	CK1F2H102K	0.001 mF 500V			
C911	56625105	10000 mF 25V			
C912	5661601B	1 mF 16V			
Discharge Caps:					
Z801	599030001	EGP-H751A			
Z802					
Z803					
Switches:					
*SW-1	PE13-1567	115V/230V Power Line Slide Switch			

WARNING

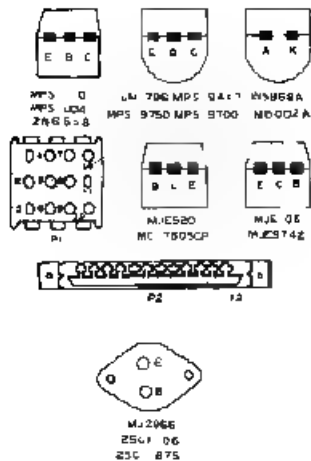
Safety-Critical Components

Components marked with an asterisk (*) on the parts list and with gray shading in the schematic have special characteristics important for safety.

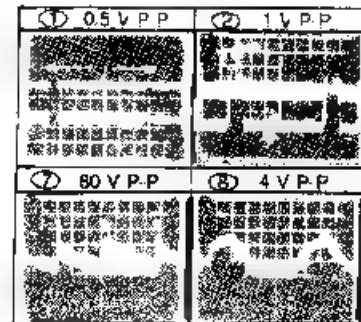
You may create shock, fire, or other hazards by using a replacement that does not have the same characteristics as the recommended part.



TR IC and Connector Lines



WAVE FORMS



NOTES

1. Unless otherwise specified, all resistance values are in ohms.
2. Unless otherwise specified, in the schematic diagram all capacitor values less than 1 are expressed in mfd. and values more than 1 are in pfd.
3. Voltage readings are taken with VTVM from point indicated on chassis to ground.
4. All waveforms are measured with strong signal input and contrast set to give normal picture.
5. This schematic diagram covers basic or representative chassis only. There may be some differences between actual components on chassis and the schematic diagram.

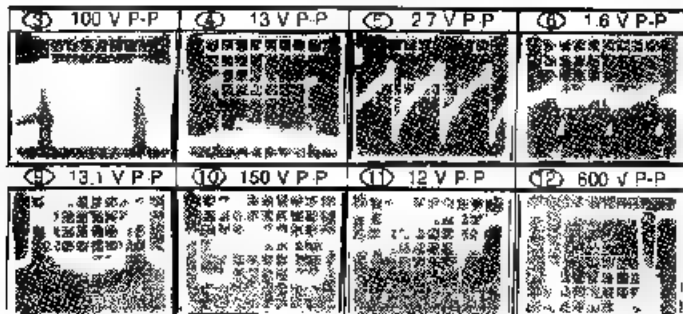
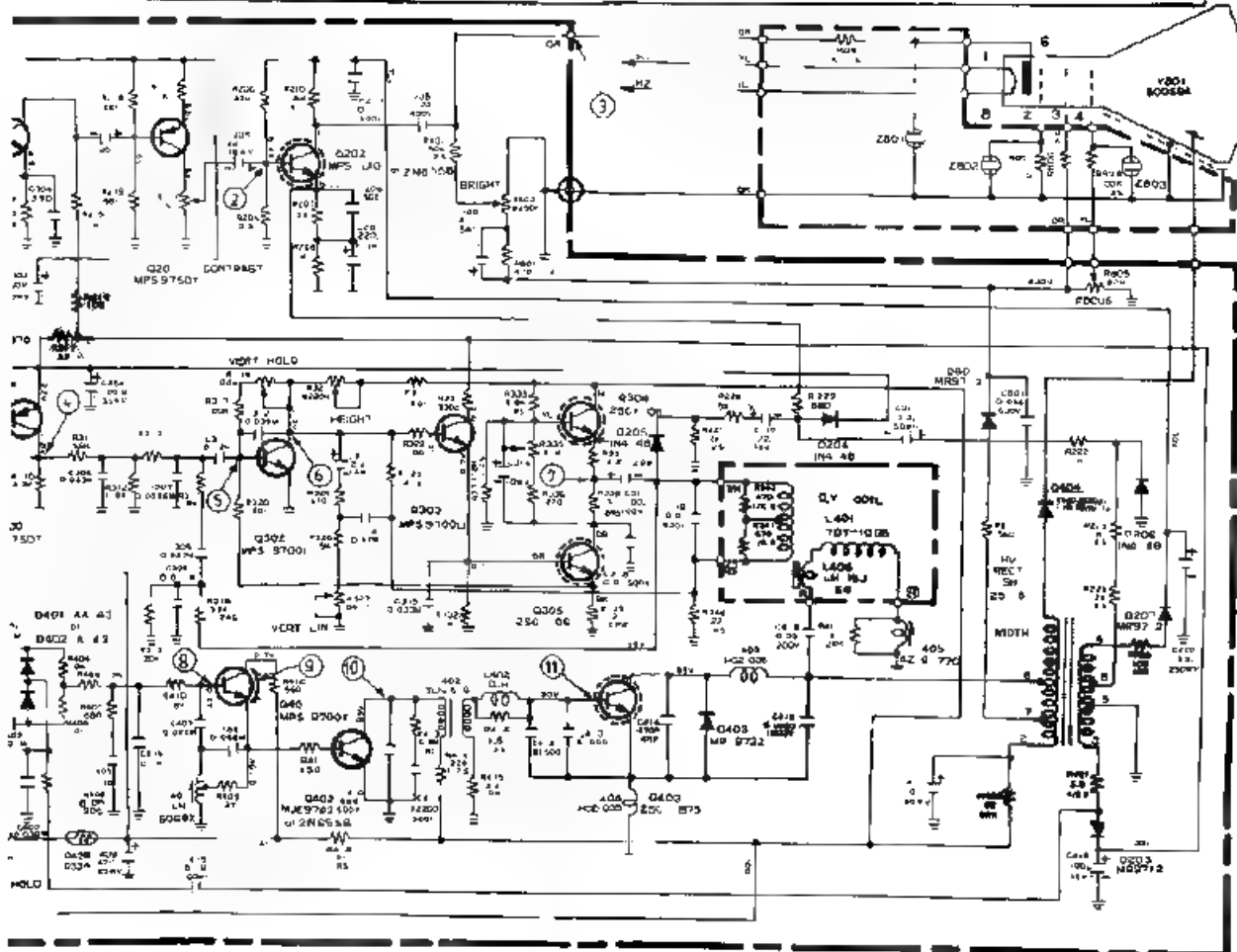
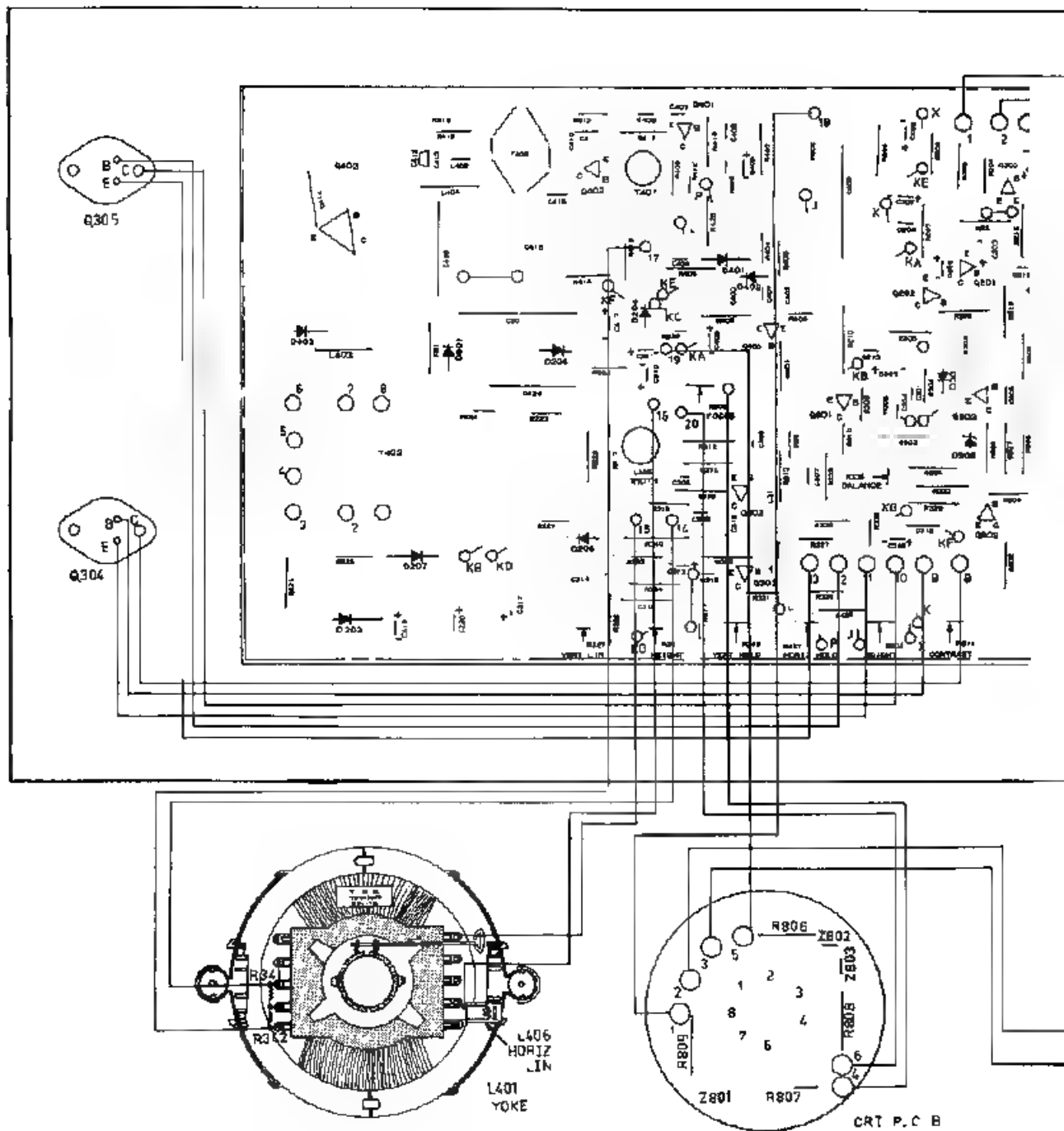
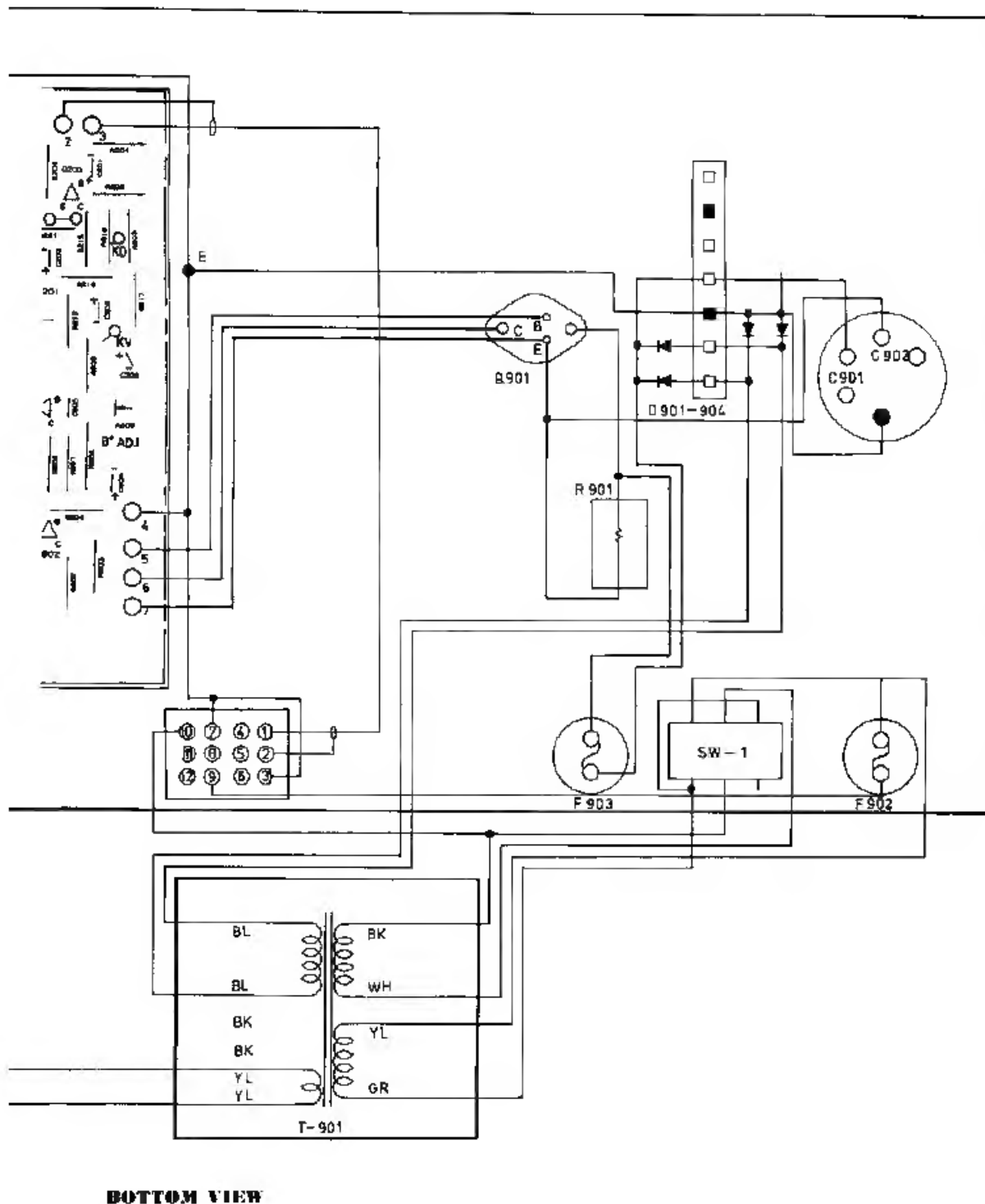


Figure 6-20 TEC Monitor Schematic Diagram





BOTTOM VIEW

Figure 6-21 TEC Monitor Wiring Diagram

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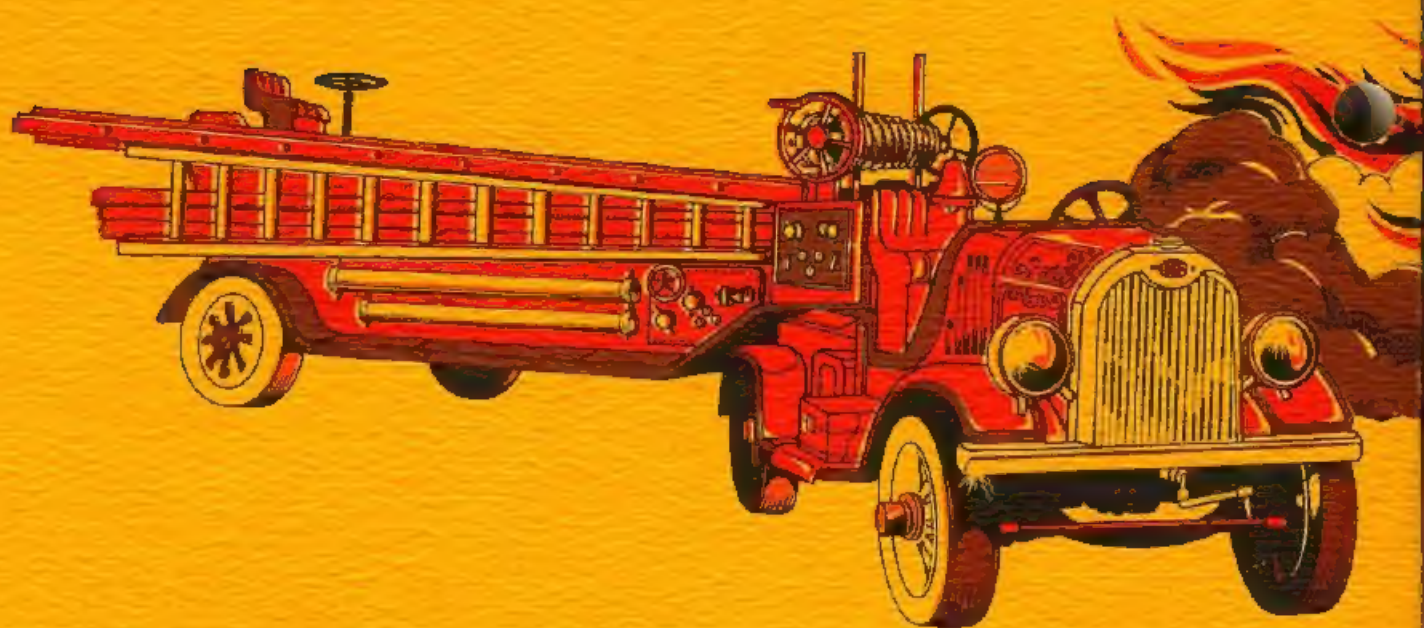
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